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A Biological Investigation of the Caloosahatchee Estuary of Florida

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GORDON GUNTER, EDITOR

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A Biological Investigation Of the Caloosahatchee Estuary Of Florida

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A. Introduction

A biological sampling program in the lower Caloosahatchee River and Estuary by District and consultant biologists was authorized by the Office, Chief of Engineers on 7 May 1957. This survey of the effects of Lake Okeechobee discharge and local runoff through the Caloosahatchee River on the fishes and animals of this Gulf estuary was a continuation of a previously authorized study of Lake releases to the Atlantic Coast (Gunter, 1959).

Scope and purpose of this work was to: (a) Review the history of the Caloosahatchee River and analyze the problems concerned with discharges into the Estuary; (b) present biological data from investigations of the Estuary made at different times during the years 1957 to 1960, inclusive; (c) determine the biological effects of operation of Moore Haven and Ortona Locks, and the planned lock and dam at Olga with reference to important indicator species within the lower river and estuary; and (d) determine operational procedures, practicable within specific operational requirements of the project, which would be either beneficial or of least damage to estuarine fishes and fishing.

The report (Gunter and Hall, 1962) was submitted to the Jacksonville District, Corps of Engineers, U. S. Army. The present paper concerns biological and ecological data, many details of which were not necessary to and were not included in the general report to the Corps of Engineers.

Acknowledgments. — Mr. Chester Adams, boat operator, Clewiston Area Office, Corps of Engineers, and Messrs. Robert Highsmith and Paul Berry, Survey Branch, Jacksonville District, ably assisted in the field collections. Dr. Victor G. Springer, then of the Marine Laboratory of the Florida State Board of Conservation, made one round of stations with us and assisted in collecting and in the field identifications. Dr. R. D. Suttkus identified a fresh water fish and Mr. C. E. Dawson checked some larval fish identifications. Dr. David Causey identified some isopods and Dr. Fenner Chace checked some of the palaemonid shrimp. Dr. Donald R. Moore and Dr. J. R. E. Morrison identified some of the mollusks.

B. Basic Considerations

Location. — The Caloosahatchee River Basin is in southwestern Florida. The watershed encompasses parts of Lee, Glades, Charlotte, and Hendry counties. The Basin is bounded by the Gulf of Mexico on the west, the Peace River and Fisheating Creek watersheds on the north and northeast, Lake Okeechobee and the Devils Garden area of the Everglades region on the east and southeast, and the cypress swamps of the Everglades on the south. State Roads 80 on the south bank and 78 on the north bank parallel practically the entire length. The Caloosahatchee River Canal is a part of the cross-state Okeechobee Waterway that extends from the Atlantic Ocean near Stuart to the Gulf of Mexico southwest of Fort Myers. It is also one of the two

primary outlets used in regulating Lake Okeechobee levels under the Central and Southern Florida Flood Control Project. The location of the area under consideration and its relation to the overall Project are shown on Plate 1.

History. — The Caloosahatchee River originally was a natural water course from Lake Flirt (near La Belle) to San Carlos Bay on the Gulf, a distance of 49 miles. In 1884 a canal was constructed by private interests between the river headwaters and Lake Okeechobee for water control and navigation. The river and canal were improved from time to time. Certain details of these improvements were given by Gunter and Hall (1962) and they will not be repeated here. In summary it may be said that the Caloosahatchee River between Lake Okeechobee and the Estuary has been canalized, with locks and water control structures at Ortona and Moore Haven. The latter is used as a spillway for releases from Lake Okeechobee. As a part of the Intracoastal Waterway Project, in 1960 a new 9x100 foot channel was cut across San Carlos Bay from north of Punta Rassa southwest to a connection with the old Intracoastal Waterway channel south of St. James City on Pine Island.

Description of the General Area—Caloosahatchee River. — The watershed of the Caloosahatchee River has a length of about 63 miles from Lake Okeechobee to the Gulf of Mexico (Plate 2). The river proper widens appreciably at Beautiful Isle, six miles above Fort Myers, Florida, and becomes an estuary. Gulf tidal effects reach as far upstream as Ortona Lock, about 32 airline miles above Beautiful Isle. The total drainage area of the river and estuary is 1,245 square miles, of which 129 square miles drains directly into the Estuary. The basin has a maximum width of 35 miles and an average width of about 20 miles. The land rises to elevation 78 feet on the north, and the ridge south of the river reaches a maximum elevation of about 40 feet. Generally, the slope of the terrain ranges from the flat lands in the vicinity of Lake Okeechobee to about 2½ feet a mile for the area north of Caloosahatchee River. South of the river, the land slopes perceptibly for several miles from the river but then flattens to slopes of less than one-half foot a mile. That area contains numerous sloughs and swamps, and the drainage is very poor. Flooding on those lands occurs almost annually and lasts for several months during the wet season. North of the Caloosahatchee River, the area is generally steeper and is fairly well drained by the many creeks and runs which extend from the river toward the uplands. Orange River, which discharges into Caloosahatchee River just upstream from Beautiful Isle, is the largest tributary and serves a drainage area of 96 square miles. Local runoff from the watershed—most of which occurs during the wet season from June through October—averages about 11 inches annually. Estimated maximum and minimum annual runoffs, excluding Lake Okeechobee discharge, were about 20 inches in 1953 and 5 inches in 1950.

There are several communities along the banks of the river, the largest being Fort Myers, on the south bank of the Caloosahatchee Estuary, with a population of about 14,000. The smaller towns upstream are Olga, Tice, La Belle, and Moore Haven. The area away from the river is sparsely inhabited. From Fort Myers to La Belle, the land is devoted to citrus production and to generally unimproved pasture-

lands. The remainder of the watershed is devoted principally to cattle pasturage and cypress timber operations.

Caloosahatchee Estuary.—The area involved in this study consists of the Estuary proper and the adjacent inshore waters extending from Beautiful Isle above Fort Myers to San Carlos Bay on the Gulf, a distance of 20 miles. Pertinent reference points are shown on Plate 2. The Estuary down to Shell Point, a distance of about 16 miles, is merely a widened part of the river in which fresh and tidal waters mix. It is about 2 miles wide at its widest section near Fourmile Point and 2400 feet wide at its narrowest section near Shell Point. Total surface area, volume, and shoreline miles at mean low water are 14,950 acres, 59,780 acre feet and 41..8 miles respectively. Mean tidal range at Punta Rassa, just outside on San Carlos Bay, is 1.7 feet decreasing to a range of 0.7 foot in the vicinity of Fort Myers. The Estuary is subject to considerable seasonal and daily changes in salinity. During the rainy season the waters in the vicinity of Fort Myers generally become fresh, and reduced salinities occur far downstream in the Estuary, with a discharge rate as low as 4,600 c. f. s. Surface salinities as low as 4.3 parts per thousand have been recorded at low tide around Shell Point with river discharge of 8,000 c. f. s. below Fort Myers. Bottom salinities at the same time were 5 to 10 parts higher. At the height of the daily tide cycle bottom salinities returned to 50-75% normal and surface salinities to 25 to 50% seawater strength. Although some maintenance dredging of the navigation channel is necessary, no large deposits of sediment and organic materials have resulted from past discharges into the Caloosahatchee Estuary.

The outer part of the area consists of several bays and sounds formed from two main islands, Pine and Sanibel, and numerous small keys lying between the mainland and the Gulf of Mexico. Both Pine Island Sound to the west of Pine Island and Matlacha Pass to the east extend from San Carlos Bay north to the mouth of the Peace River, and both carry some fresh water southward to mix with waters of the Caloosahatchee Estuary. The tip of Sanibel Island extends eastward to just south of Punta Rassa on the mainland, and between those two points lies the most direct opening from the Caloosahatchee River into the Gulf. Salinities in the outer area generally range from 25.0 to 35.0 parts per thousand between Punta Rassa and Sanibel, although much lower readings have been recorded during rainy seasons and high river flows, especially at the surface during low tide cycles. Mean low water elevations are about 0.9 foot in San Carlos Bay. Some records of salinities in various parts of the Estuary and corresponding approximate river discharges into the Estuary below Fort Myers are given in Table 1. Bottom and surface salinity profiles for the entire Estuary and outer bays, based on available sample data in 1957-1959, are shown on Plate 3. In general, within the range of discharges estimated, the effect of fresh water rapidly diminishes in the relatively unconfined waters past Shell Point. The degree of freshening and its areal extent varies almost directly with the quantities of flow. For the lower range of inflows, the data indicate only small effect on salinity.

Discharges into Caloosahatchee Estuary. — Records of discharge from Lake Okeechobee through Moore Haven Lock are available since 1939 from the U. S. Geological Survey. Present capacity of the Moore Haven Lock limits discharge to 4500 c. f. s.

Table 1

Recorded salinities in various parts of Caloosahatchee Estuary and approximate river discharges below Fort Myers

Area		Salinity (1) (parts per thousand) Low tide	High tide (2)	Dischg. (c.f.s.)
1. Fort Myers	6-24-53	0.8	2.0 S	4,710
Fort Myers	7-30-53	0.9	— S	7,290
Fort Myers	9-10-53	0.9	— S	10,000
Fort Myers	3- 2-54	0.1	0.4 S	3,950
Fort Myers	5-25-54	0.1	0.2 S	4,110
Fort Myers	6-29-55	4.7	— S	4,290
Fort Myers	7-27-55	0.0	— S	3,830
Fort Myers	8-11-55	0.1	— S	4,250
Fort Myers	8-24-55	1.3	— S	4,920
2. Shell Point	7-23-53	17.3	25.5 S	3,110
Shell Point	7-23-53	18.1	30.2 B	3,110
Shell Point	9- 3-53	4.3	13.9 S	7,930
Shell Point (various stations)	9- 3-53	13.9	26.5 B	7,930
Shell Point	9- 3-53	5.2	12.3 S	7,930
Shell Point	9- 3-53	14.1	23.0 B	7,930
Shell Point	4- 1-54	(3) 12.7 S		3,790
Shell Point	4- 1-54	(3) 25.5 B		3,790
Shell Point	9-18-54	14.3	— S	4,550
Shell Point	9-18-54	16.6	— S	4,550
3. Off Punta Rassa	9- 5-53	7.9	27.6 S	11,410
Off Punta Rassa	9- 5-53	12.6	27.8 B	11,410
4. Between Punta Rassa and Sanibel Island	7-21-53	22.9	33.5 S	960
Between Punta Rassa and Sanibel Island	7-21-53	27.6	32.2 B	960
Between Punta Rassa and Sanibel Island	9- 5-53	14.9	29.3 S	11,140
Between Punta Rassa and Sanibel Island	9- 5-53	19.7	29.5 B	11,140
5. Off Sanibel Island	9- 2-53	19.9	21.4 S	8,120
Off Sanibel Island	9- 2-53	22.4	27.7 B	8,120

NOTES: (1) Taken from Preliminary Report of University of Miami Marine Laboratory and data furnished by Red Tide Field Studies Office, Naples, Fla. Approximate sea strength = 36.0 parts per thousand.

(2) S = surface; B = bottom

(3) Tide height unknown

Lake Okeechobee stage (ft.)	Regulatory discharge (c. f. s.)
13.5	3100
15.0	4000
15.5	4300
15.8	4500
16.5	4500
17.5	4500

Bankfull capacity of Caloosahatchee River below Ortona Lock limits discharge through that structure to about 8,000 c. f. s. at present.

Discharge measurements over a period of record indicative of local runoff for the Caloosahatchee River Basin are not available. The maximum discharge of record in the few miscellaneous readings was 12,600 c. f. s. at Alva on October 1, 1948. However, estimates of the total annual runoff from the basin into the Estuary, exclusive of Lake Okeechobee releases, and discharge hydrography for various points in and above the Estuary have been developed from rainfall and available stage records.

The estimated total annual volumes of water discharged into the Caloosahatchee Estuary from all sources (Lake release plus watershed) during the period 1947-1960 are given in Table 2.

Over this period of record Lake Okeechobee has contributed the greater portion of the total discharge into Caloosahatchee Estuary, although the number of years in which either the Lake or the watershed contributed more water was equal. Estimated peak discharges from the watershed into Caloosahatchee Estuary at Fort Myers and at Shell Point during some previous flood years were as follows:

	Fort Myers	Shell Point
September 1947	18,600 c. f. s.	19,500 c. f. s.
September 1948	19,200 c. f. s.	20,300 c. f. s.
October 1951	19,600 c. f. s.	20,400 c. f. s.

C. Effects of Fresh Water Discharge

The General Situation. — The problems of the Caloosahatchee River with respect to the flow of fresh water into the Estuary are quite different from those of the St. Lucie Canal, the Atlantic outlet of Lake Okeechobee (cf. Gunter, 1959), because the Caloosahatchee River has always carried fresh water from its watershed into the Estuary and adjacent bays.

In 1884 private interests cut a canal from Lake Okeechobee to the river and from that time the natural river flow has been augmented by water from Lake Okeechobee. Additionally, peak runoff from the watershed has increased a little due to "improvements." The total annual runoff from the watershed has increased very little. The present peak river runoff is about 20,000 c. f. s. and water from Lake Okeechobee cannot be released when the river is high. The maximum Lake outflow under present conditions is 4500 c. f. s. It may be said

Table 2

Total annual discharges into Caloosahatchee Estuary from all sources, 1947-60

Year	Watershed only 1,000 acre ft.	Lake discharge 1,000 acre ft.	Total 1,000 acre ft.
1947	1,600	1,712.8	3,313
1948	1,190	1,792.8	2,983
1949	1,050	935.8	1,986
1950	256	66.1	322
1951	757	435.0	1,192
1952	1,335	828.2	2,163
1953	1,227	1,579.4	2,806
1954	880	1,984.4	2,864
1955	657	309.2	966
1956	305	20.7	326
1957	960	903.5	1,863
1958	740	1,199.6	1,940
1959	1,210	1,392.0	2,602
1960	735	1,975.5	2,711
	12,902	15,135.0	28,037

that Lake Okeechobee water has contributed to the length of time of high river flows during some years, but it has been controlled so as not to increase flood peaks.

The various channel deepenings have permitted water to flow out faster. As a result, the salt water area of the lower river was formerly subjected to longer stands of fresh water than exist today, but today greater masses of fresh water enter the Estuary and outer area in a given time. Future plans for the river will probably accentuate those conditions.

Sedimentation is not known to be a problem in the Caloosahatchee Estuary and so far as habitat goes the chief concern is with salinity change. Two groups have been concerned with instability of the salinity regime, the sports fishermen and commercial crabbers.

Previous Studies. — Murdock (1954) submitted a report to the Corps of Engineers on a preliminary survey of the Caloosahatchee and St. Lucie Estuaries. He collected and presented some data on salinity, turbidity, hydrogen ion and oxygen content. His conclusions were:

Conditions are sufficiently severe during conditions at or near maximum release to cause temporary movements of marine life from the lower river, the southern part of Matlacha Pass, and sections of San Carlos Bay. These conditions are also severe enough to cause the death of some forms unable to move from these areas. The sports fishery is hampered in the areas mentioned. This is minimized by the fact that anglers may make good catches by traveling short distances into areas adjacent to those mentioned. Businesses engaged in rent-

ing boats and selling live bait to the sport fisherman on the lower river and at Punta Rassa suffer. Changing water conditions, due to the water releases, cause loss of live bait at times. Commercial fishermen using hook and line are forced to travel out of the area to make good catches during conditions of maximum or near maximum water release. Commercial crabbers appear to be affected by the water releases which force them to travel farther in order to make their catches. The scallop fishery is not directly affected by the water releases. The major commercial net fisheries are not affected to any degree by the water releases. The offshore charter boat fishery is not affected by the water releases. Some sediments are being deposited in the Caloosahatchee River but do not affect to any degree the fisheries of the Estuary. The continuing high rate of water release from the Caloosahatchee River may be a contributing cause of Red Tide outbreaks. On the other hand, since Red Tide outbreaks show a general correlation with the cumulative monthly rainfall of the peninsula, it is probable that the contributions of the Peace River and other drainage systems are sufficiently large so that a reduction of flow in the Caloosahatchee would have little, if any, effect upon the probability of Red Tide outbreaks.

The Office of River Basin Studies, Fish and Wildlife Service, issued a report in January 1957, based on a study stated to have cost $500, which concluded that: "(a) existing fisheries of the Caloosahatchee River and its estuary are of low quality and value due to adverse effects on the natural environment of past construction works; (b) past regulatory and flood control discharges through the Caloosahatchee River have had adverse effects on the sport and commercial fisheries of the estuary; (c) these conditions are likely to persist, and they may be extended by the proposed project to include the sport and commercial fisheries of San Carlos Bay, Matlacha Pass. and Pine Island Sound; (d) waterfowl resources of the estuary and adjacent inshore waters may be endangered; (e) discharges from the Caloosahatchee River may have some bearing on the red tide phenomenon of the Florida lower west coast." The sports fishery values of the river and estuary were set at $187,000 annually.

Horel (1960) submitted a study of the fish populations above and below the Ortona Locks for the Florida Game and Fresh Water Commission. He concluded that fishes were scarce along the canalized part of the river and recommended that all ox-bows along the river be preserved and that underwater berms be dug along the river where the banks are steep.

In December 1960, the Fish and Wildlife Service furnished the Jacksonville District, Corps of Engineers, a preliminary draft of a report based on a one-year "comprehensive" survey of the Caloosahatchee River, Estuary and adjacent waters. The conclusions were similar to those of the January 1957 report (see above except that the fishery and wildlife values were revised. The conclusions and figures are not used here for they were stamped **not for publication.** This report presented some fishery statistics and some physical data from the Corps of Engineers files. No new data were presented.

Phillips and Springer (1960) made two collecting trips each to the lower Caloosahatchee area in May 1958 and February 1959 and reported on the plants and fishes caught. During the first two trips Lake Okeechobee water was being released at the rate of about 2600 to 3800

c. f. s. and during the second two there was no lake discharge. They reported the temperatures and salinities at 14 stations in the Estuary from the Edison bridge seaward, and in the adjacent bays and sounds, and the plants and fishes taken at these stations. It was concluded that no significant damage to plants was caused by discharge of 2850 c. f. s. from Lake Okeechobee. Nothing unusual was reported in the fish catches.

Area Sport and Commercial Fisheries. — The sport and commercial fisheries of the Caloosahatchee River, its estuary and adjacent bay waters have been adequately described in the various reports cited above, and details will not be presented here. In summary, the river fishery is of low quality except in the tailraces at Moore Haven and Ortona locks and dams, and near the fresh-salt water mixing line. Counts at these dams during recent years have shown a steady increase in numbers of fishermen and pounds of fish caught. Fisherman-use at Moore Haven Lock increased from 1,358 in 1957 to 4,198 in 1960; from 6,600 to 9,919 in the same period at Ortona Lock. Heaviest use is in early spring and late fall months during periods of moderate discharge. In the best year 9,000 pounds of fish were caught at Moore Haven and 11,000 pounds at Ortona. Freshwater species including bass, sunfishes, catfish, crappie, and marine forms such as mullet, snook and tarpon snapper, jack and drum, dominated the catch.

The Estuary sport fishery centers around spotted trout, yellowtail, gafftop catfish, snook, and freshwater forms in periods of high inflows. The principal game fishes of the outer bays and mangrove islands are sea trout, sheephead, mangrove snapper, redfish, grouper and snook. Spanish mackerel and other non-estuarine species enter the catch only in the offshore waters.

The commercial fishery in the Estuary and inshore waters is based primarily on mullet, sea trout, redfish, blue crab, and bay scallops. The 1958 catch of these species in Lee County totaled over 9 million pounds. Only the blue crab is harvested in the Estuary proper. The fishes and the bay scallops are taken from the inner bays and sounds. Although there are numerous oyster reefs in the vicinity of the Estuary mouth, there has been no commercial production for many years. Commercial harvesting of shrimp is illegal in Lee County but the Estuary and adjacent bays are nursery grounds for the pink shrimp which is harvested in offshore waters.

D. The Present Investigation

The present study is based on a comparison of the fishes, shellfishes, and other aquatic organisms, and the physical conditions found at selected stations throughout the Estuary in all seasons and under varying conditions of freshwater discharge. Emphasis in the investigation was placed on the small food and bait fishes and other animals and the young fishes. These groups are normal, seasonal inhabitants of estuaries, and being more easily sampled than adult forms, they furnish generally reliable indications of the temporary and permanent effects of physical changes in the estuarine environment on its inhabitants and overall production.

Collection of Basic Data. — Sampling Gear and Methods — Trawl samples were collected with a 20-foot otter trawl of 1-inch stretch

mesh in the main trawl section and ½-inch stretch mesh in the bag. All trawl hauls were of 15-minute duration in water at least 7 feet deep. Seine samples were collected primarily with a 50-foot, ¼-inch-mesh beach seine, the middle 25 feet of which was backed with bobinet material. Occasional supplemental seine drags were taken with a 20-foot, ¼-inch-mesh minnow seine. Top and bottom water temperatures and water samples for salinity determination were taken along with each trawl and seine sample. Salinities in parts per thousand were determined from direct-reading salinity hydrometers with correction for temperature. In certain instances when the salinities in the water samples were too low for determination with the hydrometers, total chlorinities were determined by titration by Dr. Robert Miller, chemist, of Fort Pierce, Florida. Those values were later converted to total salinities. All fishes and organisms collected in each trawl or seine haul were counted and measured according to species. Specimens whose identity could not be readily determined were preserved for later study at the Gulf Coast Research Laboratory.

Location and Description of Sampling Stations. — The approximate locations of the various trawl (TS) and seine (SS) stations are shown on Plate 2.

Trawl Stations. — Eight trawl stations were selected, extending from the head of the Estuary and out into the saltier waters of San Carlos Bay. Four trawl stations were in the Estuary and four were in the adjacent outer waters. These stations covered the salinity gradient from fresh or nearly fresh water to full sea water. Station descriptions are given below:

TS No. 1 — In channel southwest from marker 56; southwest of Beautiful Isle; depth 7-8'; muck bottom with much plant debris and dead *Rangia* shells with live mussels.

TS No. 2 — South and west of small island immediately downstream from Edison bridge, depth 7'; bottom-muck, algae, debris and shells.

TS No. 3 — In the river channel south of marker 27 off Niggerhead Point, depth 8-14'; muck bottom with many shells.

TS No. 4 — In channel south from marker 15 opposite Shell Point along north shore; depth 11-18'; bottom-muck with much shells and vegetation. (Moved upstream a mile, last 7 trips, due to shell bottom.)

TS No. 5 — In channel off Punta Rassa from Marker 3 south; depth 11'; muck, plant debris, and attached sea grasses.

TS No. 6 — Entrance to Matlacha Pass between Pine Island and Merwin Key; depth 7'; bottom with much vegetation, (sea grasses) debris and oyster beds (only two samples, because shell tore nets).

TS No. 7 — In channel in entrance to Pine Island Sound between Pine Island and Sanibel Island; depth — 11-14', bottom-much vegetation (sea grasses) and shell.

TS No. 8 — San Carlos Bay, in channel on Ferry line between Sanibel Island and Punta Rassa; depth 11'; hard bottom with some plant debris and shell.

(2) **Seine Stations.** — Initially eight seine stations, extending over

the salinity gradient from the head of the Estuary to sea water on the outer beach of Sanibel Island, were chosen. Attempts were made to have seine stations as close to the trawl stations as possible, but this was not always feasible, and various suitable seine station sites were utilized. Because of poor beach conditions Seine Station No. 6 was visited only twice. One to three hauls were made at each station, so as to get a representative sample of the fish and other animals present. Four seine stations were in the Estuary and three were in the adjacent outside waters. Brief station descriptions are given below.

SS No. 1 — Beach on southwest point of Beautiful Isle, north of Marker 27; lots of filamentous algae and *Vallisneria*, floating and stranded hyacinth, old oyster and *Rangia* shells, mangroves.

SS No. 2 — Sand bar and spit on west side of island just below Edison bridge at Fort Myers; hard sandy bottom with little vegetation. Willows and pine trees on island.

SS No. 3 — Sandy beach on east shore from Marker 27 inside Niggerhead Point; algae.

SS No. 4 — Beach on northwest tip of spoil island north of Shell Point; gravel bottom with few shells or vegetation.

SS No. 5 — Beach by the small shack north of the fishing dock at Punta Rassa; considerable vegetation (fine grass) and shells.

SS No. 6 — On Pine Island. Not sampled more than once due to unsuitable beach.

SS No. 7 — Beach on inner northeast corner of Sanibel Island at Woodrings Point—just opposite St. James City on Pine Island; some shells and sea grases.

SS No. 8 — Gulf beach on southwest part of Sanibel Island; hard sand bottom with many small shells.

Sampling During the Period of Investigation. — Sampling was begun on 13 May 1957 and continued about once every four months for three years, ending on 2 June 1960. Each sample period took two days. The beginning dates for each sample period are given below.

BEGINNING DATES — CALOOSAHATCHEE SAMPLING

1957	1958	1959	1960
13 May	29 January	29 January	2 March
25 September	21 May	25 June	2 June
	29 October	1 December	

The numbers of hauls with the two types of gear are shown in Table 3 divided into the Estuary proper and the adjacent outside high salinity waters. Thirteen to sixteen stations were sampled approximately every four months for three years. These were about equally divided between the Estuary and outside waters.

Physical Conditions During Study Period. — (1) Fresh water discharge into Caloosahatchee Estuary. — The Lake Okeechobee regulation schedule in use during the period 1957 through 1960 operated Lake levels seasonally between 12.5 and 15.5 feet. Under that schedule, discharges were made through the Caloosahatchee River, up to

Table 3

Number of samplings with different gear in the Estuary and outside adjacent waters for each collection period

	1957 May	1957 Sept.	1958 Jan.	1958 May	1958 Oct.	1959 Jan.	1959 June	1959 Dec.	1960 Mar.	1960 June		
Trawl												
Estuary	4	4	4	4	4	4	4	4	4	4	=	40
Outside	4	4	3	3	3	3	3	3	3	3	=	32
Totals	8	8	7	7	7	7	7	7	7	7	=	72
Beach seine												
Estuary	7	8	6	7	4	4	4	7	7	6	=	60
Outside	7	8	5	7	3	5	3	6	5	6	=	55
Totals	14	16	11	14	7	9	7	13	12	12	=	115
									Grand Total			187

outlet capacity of 4,500 c. f. s., whenever the Lake elevation was in zones A and B, unless local inflow utilized the full downstream channel capacity. The opening of the gates on 14 May 1957 was the first Lake regulatory release of any consequence through the Caloosahatchee River since August 1955. Major non-discharge periods from the Lake during these four years occurred from 26 October 1957 through 13 January 1958, and 10 September 1958 through March 1959.

Total volumes of water discharged from the Lake and watershed during those years are given in Table 2. The total volume of water discharged increased in each of the four years. The greatest runoff from the watershed occurred in 1959 and the lowest in 1960, which was the year of the highest volume from the Lake. Only in 1957 was the proportion of total discharge greater from the watershed (52%) than from the Lake. In 1958 Lake releases accounted for about 62% of the total discharge into the Estuary; in 1959 about 53%, and in 1960 about 73%.

Average discharges into the Estuary from the Lake and from all sources during the various fish sampling periods are given in table 4. During 4 of the 10 sampling periods there were no releases being made from Lake Okeechobee. During two of these same periods in the fall and winter of 1958-59, the total fresh water inflow was very low, and on another, June 1959, occurred the highest discharge experienced during the investigation. On 21 May 1958, the total discharge into the Estuary was the result of Lake releases. The range of total discharge for all 10 periods was 500 to 12,300 c.f.s., and the average was 4,675 c.f.s. Fish samples taken in the same months of different years, June 1959-60 and January 1958-59, permitted comparative observations of seasonal variations with both very low and high total freshwater discharges and resulting salinity conditions.

(2) **Salinity conditions.** — The range and average of surface and bottom salinities from station collections in the Estuary proper and in the outer bays for each sampling period are summarized in table 4. Rates of freshwater releases from Lake Okeechobee and total dis-

TABLE 4

Number of Samples, Range and Average of all Salinity Readings in the Caloosahatchee Estuary and adjacent outer bays for each sampling period, 1957-60

(Readings in parts per thousand)

		Caloosahatchee Estuary, Beautiful Island — Shell point				Adjacent Outer Waters, Punta Rassa — Sanibel Island			
		SURFACE		BOTTOM		SURFACE		BOTTOM	
Date	Discharge (cfs)*	No. samples	Range and average	No. samples	Range and average	No. samples	Range and average	No. samples	Range and average
1957									
May 13-14	750-3,500	8	3.1-31.2 (15.2)	4	3.3-33.3 (17.3)	8	31.6-37.5 (34.7)	4	31.2-37.2 (34.7)
Sept. 25-26	2,800-7,200	8	0.13-11.1 (2.3)	4	0.17-16.0 (5.4)	8	14.8-31.0 (21.3)	4	26.5-34.0 (29.9)
1958									
Jan. 29-30	2,690-7,800	8	0.12-6.6 (1.20)	4	0.12-11.0 (2.9)	6	1.6-29.1 (13.7)	3	22.3-25.6 (24.2)
May 21-22	3,210-3,210	8	0.17-10.3 (2.7)	4	0.18-21.2 (7.3)	6	20.7-35.5 (30.2)	3	29.7-34.2 (32.3)
Oct. 29-30	0-500	7	1.0-26.3 (11.1)	4	1.0-24.1 (12.5)	6	28.5-34.3 (31.6)	3	30.5-33.8 31.7)
1959									
Jan. 29	0-625	8	4.8-28.4 (15.0)	4	8.6-27.5 (18.1)	6	30.2-34.1 (32.2)	3	31.3-33.7 (32.3)
June 25	0-12,300	8	0.09-2.2 (0.62)	4	0.09-4.9 (1.29)	6	4.6-26.5 (12.7)	3	22.5-24.5 (23.3)
Dec. 1-2	4,080-4,780	8	0.12-9.8 (1.9)	4	0.14-17.3 (4.5)	6	19.5-32.4 (24.5)	3	21.4-26.6 (24.3)
1960									
March 2-3	2,280-3,330	7	0.22-12.8 (3.0)	4	0.26-12.6 (4.2)	6	28.2-33.7 (30.8)	3	27.8-32.0 (30.2)
June 2-3	0-1,500	7	0.39-6.7 (1.7)	4	0.56-11.4 (3.6)	6	17.6-33.7 (26.8)	3	27.9-33.0 (30.5)

*The first figure is amount of lake release and the second is total fresh water flow into the estuary.

charge into the Estuary on those dates are included. Individual station salinities were used to develop some of the salinity profiles (Plate 3) for the entire Estuary and adjacent waters.

The salinity concentration increased steadily from the upper to the lower portions of the Estuary and outer adjacent waters, irrespective of discharge conditions. On most occasions, there was considerably more fresh water entering the Estuary than was being released from the Lake. In general, fresh water inflows as low as 3,000 c. f. s. into the Estuary from any source were sufficient to cause low salinities throughout most of it. The station at the mouth near Shell Point was most subject to tidal mixing, and consequently gave the highest salinity readings in the Estuary during all sampling periods. Two exceptions to the above stated discharge-salinity relationship in the Estuary proper were noted, which are not fully explained on the basis of tidal variations. In the May 1957 sample, with an estimated inflow of 3,500 c. f. s., salinities in the upper Estuary were about as high as ever recorded and comparatively much higher than in several periods with lesser discharge; conversely, in June 1960, with a total estimated discharge of only 1500 c. f. s., the average Estuary salinities were lower than on several occasions with higher inflows. The two years prior to May 1957 had been a very dry period, with little or no inflow into the Estuary from any source. A strong salt water wedge had probably penetrated far up to the head of the Estuary, and it is possible that it had not as yet been displaced with increased discharge at the time of the sample. In June 1960 local heavy rains falling directly on the Estuary may have resulted in lowered salinities at that time, since salinities in adjacent outside areas were still high.

Salinities in the outer bays were much less influenced than those in the Estuary by Caloosahatchee River discharge, because of proximity to the open Gulf. With total fresh water discharges up to 7200 c. f. s. average surface salinity was still above 20 p. p. t. and average bottom salinities nearly 30 p. p. t. The lowest average surface and bottom salinities (12.7 and 23.3 p. p. t., respectively) during the investigation were recorded in June 1959 with total river discharge at Shell Point estimated at 12,300 c. f. s. Readings almost that low were found in January 1958 when the discharge was 7,800 c. f. s. On all but one occasion with low surface salinities in the outer bays, the bottom salinities there were 10 or more parts per thousand higher. In December 1959 the average surface and bottom salinity were both about 24 p. p. t.

Tidal variations and the persistence of higher bottom salinities in the bays during high discharges was demonstrated during the June 1959 flood discharge of 12,300 c. f. s. from the watershed. Surface and bottom samples taken every hour at Punta Rassa (station 5) ranged from 2.6 and 11.9 p. p. t. at low tide to 21.9 and 24.3 p. p. t. at high tide. Bay stations closer to the Gulf on the same day did not go below 19.0 p. p. t. on the bottom. As in the inner Estuary the surface salinity concentration throughout the outer bay increased steadily from stations close to the river mouth to those near the Gulf, irrespective of river discharge conditions, e. g. 14.8 to 31.0 p. p. t. in September 1957 with total discharge of 7,200 c. f. s.; 17.7 to 33.7 p. p. t. in June 1960 with total dicharge of 1,500 c. f. s. Bottom salinities varied much less throughout the bay area, the range usually being from 2 to 7 p. p. t.

(3) **Temperatures.** a. **Water.** — Surface and bottom water tempera-

Table 5

Number of readings, range and average and bottom water temperatures for all Stations in each collection period, Caloosahatchee Estuary

(Readings in degrees Fahrenheit)

Date	No. of Readings	Surface Range	Surface Average	No. of Readings	Surface Range	Surface Average	Grand Average
1957							
May 13-14	12	80.2-89.6	83.9	8	80.2-83.3	82.4	83.3
Sept. 25-26	16	82.2-87.8	85.3	8	73.4-84.3	81.6	84.1
1958							
Jan. 29-30	14	60.0-67.0	64.1	6	61.0-65.0	62.5	63.7
May 21-22	14	81.0-86.0	83.2	6	81.0-82.0	81.3	82.6
Oct. 29-30	13	69.0-72.0	71.6	7	70.0-72.0	71.3	71.5
1959							
Jan. 29	13	66.0-72.0	69.9	5	66.0-71.0	68.4	69.3
June 24-25	9	87.0-90.0	88.0	3	87.0	87.0	87.7
Dec. 1-2	14	59.0-62.0	60.0	7	58.0-62.0	59.3	59.8
1960							
March 2-3	13	68.0-72.0	70.9	7	70.0-72.0	71.1	71.0
June 2-3	13	81.0-88.0	84.4	6	80.0-83.0	81.5	83.5

tures at the different stations are summarized for each sampling period in table 5. Summer and fall average water temperatures differed very little but winter temperatures varied from year to year. The winter of 1958 (January and February) was exceptionally cold and resulted in heavy losses of tourist business throughout central and southern Florida. The lowest recorded 1958 water temperature during these studies was 60° F. with an Estuary average of 63.7° F. No readings are available for the previous winter here, but, in contrast, average water temperatures from the St. Lucie Estuary on the Atlantic coast at the end of January 1957 were about 75° F., or more than 11° higher than in 1958. Fish kills were reported in many Florida bays and estuaries in 1958, but the death of fishes resulting from the cold was not observed in the Caloosahatchee area. Average water temperatures were higher, again in the winter of 1958-59 but the lowest of this investigation (58.0° F.) was recorded during December 1959. Thus, there were two mild winters (1956-57 and 1958-59) and two cold ones (1957-58 and 1959-60) just prior to and during these studies. Surface waters generally averaged a few tenths to slightly more than a degree warmer than bottom waters.

b. **Air.** — The average daily maximum and minimum air temperatures at Fort Myers for the three winter periods of this investigation (November through February 1957-58, 1958-59, and 1959-60) were extracted from Climatological Data for Florida and are summarized in Table 6. The data substantiate those of the average water temperatures, i. e. the relatively mild winter of 1958-59 was between two colder ones. The average minimum temperature in February 1959 was 16.5 degrees higher than that of the preceding February and 8.8° higher than in February 1960. Freezing temperatures occurred in three of the winter months in 1957-58, in two months in 1959-60 and only in one in 1958-59.

(4) **Aquatic vegetation.** — Plants occurring in the lower Caloosahatchee River and adjacent waters in 1958 and 1959 were reported by Phillips and Springer (1960). Particularly noticeable in our samples was the abundance of the fresh water plant, *Vallisneria americana*, or wild celery, at Station 1 near Beautiful Isle and around Fort Myers. This plant flourished during periods of high fresh water inflow and died out following winter freezes. Other fresh water vegetation found in the upper part of the Estuary included *Potamogeton* sp. and water hyacinth, *Eichornia crassipes*. The latter was especially abundant in December 1959 and March 1960. Large clumps were floating downstream and lodged around islands as far down as Shell Point at the mouth of the Estuary. Many of the regular beach stations had to be cleared of these plants before seine operations could be accomplished.

Various sea grasses, including *Diplanthera*, *Thalassia* and *Ruppia*, were common in the shallow portion of outer bays. Species of *Gracillaria*, red algae, were common in outside trawl hauls.

(5) **Summary of physical conditions in the Estuary during the study period.** — The period of the investigation was one of contrasting physical conditions. The first collection in the spring of 1957 was made after a two year dry period when there had been little fresh water discharge into the Estuary. Salinities were comparatively high as far upstream as Fort Myers. There was a heavy runoff that fall and salinities were low throughout the Estuary during the September collection. In 1958

Table 6

Range and average of maximum and minimum daily air temperatures, Fort Myers, Florida

(From U. S. W. B. Climatological Data)

	Daily Air Temperature (°F)			
	Maximum		Minimum	
	Range	Average	Range	Average
November 1957	89 - 72	82.3	71 - 51	60.8
December 1957	82 - 47	73.6	63 - 28	50.0
January 1958	79 - 53	66.9	59 - 32	47.4
February 1958	81 - 53	66.7	66 - 30	44.4
November 1958	87 - 75	83.8	70 - 55	63.6
December 1958	84 - 60	75.0	64 - 37	52.7
January 1959	85 - 53	72.9	66 - 32	50.7
February 1959	88 - 74	81.4	69 - 50	60.9
November 1959	89 - 53	79.5	70 - 34	60.8
December 1959	85 - 61	74.0	68 - 42	53.1
January 1960	84 - 55	74.4	68 - 32	51.8
February 1960	83 - 60	73.7	66 - 36	52.1

discharges were moderate to high through March but low throughout the remainder of that year and until June 1959. After the January 1958 collection, during which low salinities prevailed, the next three samples were taken under relatively high salinity conditions. The highest discharges of the three year period occurred in June 1959, when the Estuary and some of the outer bays contained fresh or brackish waters. Discharges and salinities were more normal in the remaining samples in 1959 and 1960. Temperatures, both air and water, were much lower in the winter of 1958-59 than in the other two winters. Low salinities in the Estuary were experienced on several occasions as a result of local runoff from the watershed alone and not discharge from Lake Okeechobee. Estuary fish samples were collected on three occasions of little runoff and high salinities, three times of high fresh water inflow and low salinities, and four times with moderate discharges and salinities.

The Species Account. — Collections were made at various regular stations distributed from Beautiful Isle to the Sanibel Island outer beach, over the salinity range from fresh water to sea water. These stations have been described above. No attempt was made to "beat the bushes" for the purpose of compiling a long list of species. Attempts were made to collect an adequate sample at each station, but no attempt was made to catch vast amounts of specimens at the various stations, some of which were quite populous at times. Springer (1960) listed the fishes taken during two collecting trips to the Caloosahatchee area. His paper is the only one relating specifically to the fauna of the area.

Insofar as the individual water temperatures were all within the temperate range and did not approach the upper or lower limits for any species, nothing is said about precise station temperatures. Tables 5 and 6 and the remarks pertaining thereto will stand as the temperature account.

The following account describes briefly the salient features concerning the catch of each species. The abbreviations SS and TS stand for Seine Station and Trawl Station.

Pisces

Elasmobranchii

Dasyatidae

Dasyatis sabina (LeSueur), Stingaree

One specimen, with a disk length of 300 mm., was taken at TS 3 within the Estuary on 25 June 1959. It was 487 mm. long to the tip of the tail. The salinity was 0.09 p.p.t., which is in the fresh water range. Springer (1960) reported one specimen from the same part of the Estuary in February 1959.

Osteichthyes

Lepisosteidae

Lepisosteus platyrhinchus DeKay, Florida spotted gar

One specimen 640 mm. long was taken at SS 3 on 25 June 1959. The salinity was 0.26, within the fresh water range.

Elopidae

Elops saurus Linnaeus, Tenpounder

Five specimens were taken at TS 1 and 2 on 21 May 1958. Their length range was 58-72 mm. and the salinity was 0.18 at both stations. On 3 June 1960 four fish were taken at the same stations where the salinities were 0.55 and 0.65. Fourteen fish were taken on the same date at TS 1 and 3. The salinities were 0.39 and 2.00. The length range was 75-125 mm. and the largest fish was taken at the highest salinity. Springer (1960) reported one specimen from San Carlos Bay in May 1958.

As Springer and Woodburn (1960) said, this fish is taken at all salinities and they took most of their specimens in Tampa Bay in December. However, there is probably an influx of the young to inside waters in the warm months, at least following the more severe winters, similar to what Gunter (1945) reported as an annual occurrence in Texas waters.

Clupeidae

Brevoortia patronus Goode, Gulf menhaden

One specimen 45 mm. long was taken at SS 1 on 13 May 1957. The salinity was 3.3.

Brevoortia smithi Hildebrand, Yellowfin pogy

Seventeen specimens from 25-38 mm. long were taken at SS 3 on 21 May 1958. The salinity was 1.89. Springer (1960) recorded one specimen in late May 1958 as *Brevoortia* sp. from the mouth of the Estuary. The length, 22.3 mm. SL, indicates that it was probably this species, which spawns in the spring. Neither species of menhaden was taken in the numbers found by Springer and Woodburn (1960) in the Tampa area or by Gunter (1959) across the peninsula on the Atlantic.

Dorosoma petenense (Günther), Gizzard shad

Three specimens, 39 to 100 mm. long, were taken at TS 1 on May 1958. The salinity was 0.18. Thirty-one specimens were taken outside

at SS 5 on 25 September 1957. They ranged from 58-102 mm. long. The salinity was 17.5.

Harengula pensacolae Goode and Bean, Silver sardine

One fish, 55 mm. long, was was taken at TS 4, within the Estuary, on 30 October 1958 at a salinity of 24.1. A total of 303 specimens, 48-77 mm. long, were taken just inside the Estuary at SS 4 on 30 October 1958. The salinity was 26.3. In the outside waters 223 specimens were taken at SS 5 and 8 in the months of May, June, September and October. On the outside beach of Sanibel Island 218 specimens were taken, 200 of them in one drag on 2 June 1960, all of them being about 23 mm. long. In May and October fish ranged from 60 to 110 mm. long. On 30 October 1958 four fish only 13-14 mm. long were taken on the Sanibel Beach, a fact indicating a second spawning during the warm season as postulated by Gunter (1945) in Texas waters. The outside salinities where *Harengula* was caught ranged from 26.5 to 33.7 and 215 fish were taken at 33.6 to 33.7. Weighting the salinities by the number of specimens taken at each one showed that the mean salinity at which this fish was caught was 29.3.

Springer (1960) recorded 50 specimens from waters outside the Estuary in February 1959.

Engraulidae

Anchoa hepsetus (Linnaeus), Striped anchovy

Ten specimens were taken in seines within the Estuary and 15 were taken in trawls. The length range was 46-110 mm. and the salinities were from 1.8 to 11.1. All specimens from inside were taken in June and September. One specimen was taken on the outside in trawls in January and 144 were taken in seines in March, May, June and September. Large numbers of larvae were taken in May and June. The salinity ranges were 17.5-35.5. The length ranges were 27 (larvae) to 99 mm. The largest fish were taken in September, and this held true both within and outside the Estuary.

In addition to the above, 601 mixed *A. hepsetus* and *A. mitchilli* larvae were taken inside in seines in May 1958 and September 1957. Thousands more went through the seines. Some of the larvae caught were as small as 17 mm. total length. The upper limit was 35 mm. The species were mixed and were not differentiated. They seemed to be mostly *A. mitchilli*. The salinity range was 1.6 to 11.1, and the vast majority were taken at 10.4 *per mille* in May 1958.

Anchoa mitchilli (Cuvier), Bay anchovy

Three fish were taken in trawls outside the Estuary in January 1958 and 1959. The salinities were 23.0-24.8 and the lengths were 51-65 mm. One hundred and thirty bay anchovies were taken in the seines outside the Estuary in the months of March, May, September and October and 2 in December 1959. They ranged from 43 to 67 mm. long in March to September and were 21-39 mm .long in October and December. The salinities were 14.8 to 35.7.

Within the Estuary 608 specimens were taken in trawls at salinities from 0.18 to 21.2 from March to June except 2 taken in January. Of these 504 were taken at salinities less than 2.0. The size range was 20-77 mm. and the smallest were taken in May.

A total of 1,176 bay anchovies were taken in the seine stations

within the Estuary during all months, but 895 were taken in 2 hauls in October 1958 and October 1960. The size range was 16-88 mm. and the smallest, 16-22 mm., were taken in October and January 1958. Springer (1960) has reported this species from several areas in the Caloosahatchee in May.

The salinity range was 0.14 to 28.4 but 1,083 specimens were taken at salinities less than 1.0. Gunter (1945, p. 34) has shown that in Texas waters the largest catches per haul were at less than 5.0 parts per thousand salinity. Weighting the salinities by the number of specimens taken at each one showed that the mean salinity at which the bay anchovy was taken was 4.1.

Anchoa sp.

Unidentified larvae numbering 101 were taken in June and December 1959 in seines outside the Estuary. Possibly they were *Anchoa cubana*, previously reported from the Tampa area by Springer and Woodburn (1960).

Synodidae

Synodus foetens (Linnaeus), Lizardfish

Four specimens were taken in the Estuary at TS4, one in January 1959 and 3 on 2 June 1960. The length ranges were 70-221 mm. and the salinities 27.5 and 11.4 respectively.

Nine specimens 39 to 103 mm. long were taken in March and June 1960. The salinity at both stations was 28.7. In trawls outside the Estuary 10 specimens were taken at 8 stations at all seasons. The size range was 158-265 mm. and the salinity range was 18.0-32.9.

The mean salinity for all catches was 25.3.

Springer (1960) reported small fish from the lower Estuary in May.

Cyprinidae

Notropis maculatus (Hay), Red shiner

Thirty-six specimens were taken at SS 1 and 2 in May and October 1958 and June and December 1959. The measured salinities ranged from 0.09 to 0.22. One was registered as 1.0.

Notropis petersoni Fowler, Peterson's shiner

Thirty-seven fish 28 to 54 mm. long were taken at SS 1 in December 1959 and March and June 1960. The salinity ranges were 0.12 to 0.65.

Ariidae

Bagre marina (Mitchill), Gafftop

One fish was caught in May and one in September 1957 in trawls within the Estuary at Stations 3 and 2. The total lengths were 107 and 102 mm. and the salinities were 19.8 and 0.17 respectively.

A specimen 117 mm. long was taken outside at TS 6 on 26 September 1957. The salinity was 18.0.

Galeichthys felis (Linnaeus), Hardhead

Fifteen hardhead catfish were taken at SS 2 and 3, within the Estuary on 26 September 1957. The total length range was 62-69 mm. The salinity at both stations was 0.17.

Fifteen specimens were taken in trawls outside at Stations 5, 6 and 8 in September 1957, January 1958 and June 1959. The total length ranges were 112 to 207 mm. The salinities ranged from 18.0 to 25.6.

A total of 651 fish were taken in trawls at all seasons in the Estuary. The length ranges were 63 to 300 mm. Fish less than 80 mm. long were taken in the months of September, October and January. Four hundred and eighty-eight fish were taken in January 1959. The salinity ranges were 0.09 to 19.8. The fish does not leave inshore waters in winter in south Florida as Gunter (1945 and previously) reported for the northern Gulf.

By weighting the salinities at stations where *G. felis* was caught by the number of specimens, it was shown that the average salinity where this catfish was taken was 10.8 parts per thousand. In general this catfish was taken at lower salinities than Gunter (1945) reported in Texas catches.

Springer (1960) reported 64 specimens from the Caloosahatchee in 1958 and 1959 taken at a mean salinity of 15.7.

Ictaluridae

Ictalurus catus (Linnaeus), White catfish

Two white catfish, 152 and 147 mm. long were taken in January 1958 and March 1960 at TS 3 and 1, within the Estuary. The salinities were 0.14 and 0.26 respectively. Four fish, 31 to 67 mm. long, were taken at TS 1 and 3 on 25 June 1959. Both salinities measured 0.09.

Ictalurus punctatus (Rafinesque), Channel Cat

Two specimens, 95 and 121 mm. long, were taken at TS 1 in May 1958 and March 1960. The salinities were 0.18 and 0.26 respectively.

Notorus leptacanthus Jordan, Madtom

One fish, 23 mm. long, was taken at SS 2 on 1 December 1959. The salinity reading was 0.22.

Belonidae

Strongylura marina (Walbaum), Timucu

Thirty-five specimens were taken in seine hauls outside the Estuary in the months of May and September. The lengths ranged from 55 to 335 mm. and smallest specimens (all less than 100 mm.) were taken in May, as Springer and Woodburn (1960) previously noted.

Strongylura notata (Poey), Needlegar

Eight specimens were taken in seines on the outside in the months of May, June and December. The length ranges were 50 to 340 mm. Four specimens were also taken in May and June in seines within the Estuary. The length ranges were 58 to 425 mm. The salinity range was 0.55 to 31.2. The smallest fish both inside and outside were taken in May or June.

Strongylura sp.

Thirty-seven needle gars were not identified as to species, but we believe they belonged to the two above, and that most of them were *S. marina*. Twenty-one fish were taken in the Estuary in seines in May and October. The length ranges were 34-285 mm. and fish below 100

mm. were all taken in May. The same thing may be said of 16 specimens outside the Estuary in seines in the months of May, June and October, in which the total length range was 72-171 mm. The salinity ranges were 1.9 to 31.8 for all stations.

Hemirhamphidae

Hyporhamphus unifasciatus (Ranzani), Halfbeak

Three fish, 60-78 mm. long were taken outside the Estuary at SS 5 on 22 May 1958. The salinity was 30.1.

Cyprinodontidae

Adinia xenica (Jordan and Gilbert), Banded killifish

One specimen 40 mm. long was taken at SS 7 outside the Estuary on 2 March 1960. The salinity was 28.7.

Cyprinodon variegatus Lacépède, Chub

Twenty-five specimens were taken at all months except January at Seine Stations 1 and 2. The length ranges were 17-42 mm. The smallest fish was taken in September 1957, but fish as small as 21 mm. were taken in May 1957 and June 1960. Three 33-79 mm. long were taken in October 1958 and June 1959 at Seine Stations 5 and 7 outside the Estuary. The salinity mean of the stations was 5.9, but the station salinities weighted by the number of fish showed that the fish were taken at a mean salinity of 2.8. This is much lower than Simpson and Gunter (1956) found for this species during dry conditions on the Texas coast. The numbers of fish caught were also relatively few compared to what Gunter (1945) found on the Texas coast and Kilby (1955) and Reid (1954) found farther up the Florida Peninsula at Cedar Keys. In the Tampa area Springer and Woodburn (1960) found this fish abundant only at a bayou station well inside the bay area.

Springer (1960) recorded 10 specimens from the Caloosahatchee.

Fundulus chrysotus (Günther), Gold topminnow

Six specimens were taken at SS 1 and 2 on 1 December 1959. The total length range was 29 to 39 mm. The salinities were 0.12 to 0.22. Kilby (1955) took this fresh water fish at a salinity of 24.7.

Fundulus confluentus Goode and Bean, Spotfin killifish

One specimen, 37 mm. long, was taken at SS 1 on 26 September 1957. The salinity was 0.13.

Fundulus grandis Baird and Girard, Gulf killifish

One specimen, 25 mm. long, was taken at TS 1 on 21 May 1958. The salinity was 0.18.

Fundulus seminolis Girard, Seminole killifish

Forty-eight specimens were taken at SS 1 and 2 in May and October 195 and March 1960. The size range was from 22 to 127 mm. The smallest fish were taken in May. The salinity range was 0.13 to 7.3 and 29 fish were taken in one haul at the latter salinity.

Springer (1960) has previously recorded 5 specimens from the Caloosahatchee Estuary. At one of his collection stations the salinity

was 13.5, which is the highest at which this species has been recorded.

The long, slim shape of this fish coupled with the delicate yet vivid red and pink of the breeding males, flecked with iridescent gold and silver specks when in full color, make this one of the most beautiful of all the cyprinodontids. As such it is quite different from the usual description of "olive-green" (Cf. Carr and Goin, 1955).

Fundulus similis (Baird and Girard), Striped killifish

Five fish 79 to 93 mm. long were taken at Seine Station 5, Punta Rassa, on 2 June 1960. The salinity was 17.6. Springer (1960) recorded one fish near the same location.

Jordanella floridae Goode and Bean, Flagfish

Eight fish were taken in the Estuary on 29 October 1958 at SS 1 and 2. The length range was 15-23 mm. The salinities ranged from less than one to 7.3.

One cyprinodontid, 14 mm. long taken in May 1957 at SS 1, was unidentified.

Lucania goodei Jordan, Redfin killifish

Four specimens, 19 to 29 mm. long, were taken in the Estuary at SS on 1 December 1959. The salinity was 0.20. Springer (1960) took 12 fish at one station about midway of the Estuary in May 1958 where the salinity was 1.3.

Lucania parva (Baird and Girard), Diamond killifish

A total of 297 specimens were taken. Three fish were taken outside the Estuary at Seine Station 5 in October 1958 and June 1959. The salinities were 26.8 and 9.5. Four fish were taken in the Estuary at TS 1 on 29 January 1958. The salinitiy was 0.12. A total of 290 fish were taken in the Estuary at SS 1, 2 and 3 in all months, although 189 fish were taken in the months of September and October. No other months yielded more than 10 fish except for December 1959 when 71 fish were taken in one haul at SS 3.

The size range of the fish was from 17 to 45 mm. Fish less than 20 mm. in length were take only in October and December and the only fish 40-45 mm. long were taken in the same months.

All specimens were taken at salinities ranging from 0.09 to 9.5, except 2 taken at 26.8 outside the Estuary. Gunter (1945) found this fish most abundant at salinities of 10-15 *per mille*; Gunter (1950) found it most abundant below 3.1; Kilby found it most abundant below 11.0; and Springer and Woodburn stated some factor besides salinity determines where the populations exist. The salinities weighted by the number of specimens caught show that the mean salinity at which this little fish was caught in the Caloosahatchee area was 3.5.

Springer (1960) took 33 specimens in the middle part of the Estuary in May 1958 and February 1959, at a salinity range of 0.9-11.9 and a mean salinity of 1.9.

This little fish has each scale with a dark border and is much more deserving of the name diamond killifish than *Adinia xenica*.

Poeciliidae

Gambusia affinis (Baird and Girard), Mosquitofish

A thousand and ninety-five mosquitofish were taken in the Estuary at all seine stations and at all seasons, although only 1 fish was taken at SS 4 on 30 January 1958. The salinities ranged from 0.09 to 7.3. The catches were sporadic and 1,041 fish were taken in four hauls at Stations 1, 2, 2 and 3 on 22 September 1957, 29 October 195, 1 December 1959 and 1 December 1959. The remaining 54 fish were taken in 10 hauls. Thirteen fish were taken outside the Estuary at SS 5 and 7 in January 1958 and March 1960, making a total of 1,108 for all stations.

The total salinity range was 0.09 to 28.7. A gravid female 36 mm. long was one of 4 fish taken at the latter salinity and these were the only ones taken at a salinity above 7.3. Salinities weighted by the numbers of fish taken at each one showed that the mean salinity at which this species was caught was 3.4. Slightly over 62.5 per cent of the fish were taken at salinities below 1.0.

The length range of the specimens was 12 to 44 mm. Fish below 20 mm. in length were taken only during the months of October 1958 and December 1959. Fish over 40 mm. long were taken only in January 1958 and December 1959. The latter were all females. Males ranged from 21 to 28 mm. in length. The fish were not separated into males and females, but some counts were made. A sample of 23 fish taken on March 1960 was comprised of 7 males 21-24 mm. long and 16 females 23-35 mm. long. Gravid females were noted in the months of March and September.

Heterandria formosa Agassiz, Least killifish

Twenty-one fish were taken at SS 1, 2 and 3 in nine hauls and at all seasons. One fish was also taken within the Estuary at TS 1 on 3 March 1960. Two fish were taken at SS 5 on the shore of San Carlos Bay on 29 January 1959.

The total length range was 13-28 mm. Fish below 20 mm. in length were taken in the months of January, March and December. Fish longer than 25 mm. were taken in September and December.

The salinity range at which the fish were caught ranged from 0.12 to 0.65, except for the 2 fish from San Carlos Bay where the salinity was 30.2, the mean salinity for the catches being 2.7.

Mollienesia latipinna LeSueur, Molly

Seventy mollys were taken at SS 1, 2 and 3 and in all seasons except the summer and 13 were taken outside the Estuary at SS 5 in January 1958 and 1959.

The total length range was 18-62 mm. Fish less than 20 mm. long were taken in March, September, October and December. Fish greater than 40 mm. in length were taken in January, March and May. Gravid females were noted in May 1958.

The salinity range at which the species was caught was 0.13 to 7.3, except for one of the outside hauls where it was 30.2. The mean salinity was 6.3.

Springer (1960) reported 2 specimens from the Caloosahatchee Estuary.

Syngnathidae

Syngnathus floridae (Jordan and Gilbert), Florida pipefish

Two fish were taken outside the Estuary at SS 5 and 7 on 30 October 1958. Their lengths were 112 and 102 mm. respectively and the salinities were 26.5 and 31.8.

Syngnathus louisianae Günther, Louisiana pipefish

Eleven specimens were taken. Two of these, 119 and 127 mm. long, were taken at SS 1 on 13 May 1957 where the salinity was only 3.3. Nine were taken outside the Estuary at SS 5, 7 and 8 in May 1957 and 1958 and June 1960. Their lengths were 70 to 154 mm. and the salinities were 28.7-35.5. One fish 268 mm. long was taken at TS 8 on 8 June 1959. The salinity was 24.5.

These relatively sparse collections confirmed the previous impression gained in the St. Lucie (Atlantic coast) that *S. louisianae* is more abundant in south Florida than *S. floridae* and that *S. floridae* is more abundant in Louisiana than *S. louisianae*. On the other hand, Springer and Woodburn (1960) took more *S. floridae* than *S. louisianae* in the Tampa Bay area. We took no fish approaching the maximum lengths they reported for *S. floridae*, 189 mm. standard length, and in fact our specimens were not as long as the minimum length of egg bearing males which they reported. On the other hand, the salinity of 3.3 is the lowest reported for *S. louisianae*.

Springer (1960) took 7 specimens just outside the Estuary.

Syngnathus scovelli (Evermann and Kendall), Silverstriped pipefish

One fish was taken at TS 6 outside the Estuary and 11 fish were taken at SS 5 and 7 in all seasons. The length ranges were 53-100 mm. and the salinity range was 9.5 to 34.2. Fish less than 60 mm. long were taken in May, June and October and fish 100 mm. and longer were taken in January, May and June.

It is well known that this pipefish is euryhaline, but no specimens were taken at lower salinities. This suggests that when this pipefish invades fresh water it goes in rather quickly, somewhat as if on migration, and does not move slowly into lower salinity water and then fresh water.

Springer (1960) took 11 specimens outside the Estuary.

Hippocampus hudsonius DeKay, Seahorse

Nine fish were taken at 9 hauls in trawls at Stations 6, 7 and 8, during all seasons from May 1957 to June 1960. The salinity range was 21.4 to 33.8. The total length range was 90 to 165 mm., except for a baby seahorse, 13 mm. long, taken 2 June 1960. Two seahorses 90 mm. long were taken in May 1957 and June 1960. The others were 120-164 mm.

Mugilidae

Berg (1947) did not include his order Mugiliformes (Percesoces) within the Perciformes (Acanthopterygii, Percomorphi) because of the subabdominal position of the ventral fins. Gunter, Sulya and Box (1961, p. 305) found that, "In general the blood plasma proteins of the

mullet are less complex than in the Perciformes and similar to certain species of the catfishes and clupeids." In any case we feel that the mugiloid fishes should be considered at least as primitive percomorphs, preceding others in that group, until further evidence is presented concerning the primary or secondary nature of the position of the ventral fins.

Mugil cephalus (Linnaeus), Black mullet

No mullet were taken in trawls. A total of 1,733 fish was taken in seines within the Estuary at all seasons. The total length range was 21-133 mm. and the salinity range was 0.09-28.4. Outside the Estuary 1,329 fish were caught, all but 2 in the fall and winter months. The length range was 16-89 mm. and the salinity range was 6.6-35.7.

Very few mullet were taken during the years 1957 and 1960. Two only were taken on the outside and 172 on the inside during those years. Needless to say many larger fish escaped the seines.

Table 7 shows the numbers caught by months (different years combined) and the sizes, beginning with October, the month in which the young first appeared. The young appear on the outside in large numbers in October. By January they have began to move inside. By March almost all the young had entered the inside waters and very few remained in the outside bays. This appearance and movement of the young is similar to what Gunter (1945) reported on the Texas coast, except that the small fish first appeared there in November in one year and in December the next.

The young mullet were all in what has been called the *querimana* stage up to about 25 mm. total length. Some commercial fishermen do not recognize them as mullet when they are in the larval stage.

Springer (1960) reported 51 *M. cephalus* in the Caloosahatchee Estuary in February 1959 from 23-41 mm. standard length. However, he reported 14 fish from outside the Estuary in May at standard lengths of 13.6-16.0 mm. This is quite out of line with the data previously reported by Springer and Woodburn (1960) and that reported here. For that reason we feel that there was a typographical error, or that the young mullet were actually *M. curema*. In any case no other author has reported such small *M. cephalus* in May.

Mugil curema Valenciennes, Silver mullet

One hundred and forty-five silver mullet were taken. Except for 3 specimens, 113, 133 and 172 mm. long and 9 individuals 58-74 mm., all fish were in larval and post-larval stages, 11-30 mm. total length. The small fish were taken only in May and June. Springer and Woodburn (1960) found only fish less than 30 mm. standard length in May.

Anderson (1957) has shown that silver mullet are components of the offshore plankton until they are 17-24 mm. long, and these are the smallest sizes at which they have been reported inshore. The writers took specimens as small as 11 mm. total length, the smallest known from inshore waters. Identities were checked for us by Mr. Anderson. In view of this fact a summary table of all catches of the silver mullet is presented (Table 8).

Springer (1960) reported 3 fish, 132-152 mm. standard length, outside the Estuary in May as *M. curema* or *M. trichodon*.

Table 7

Catches of *Mugil cephalus* at Seine Stations inside and outside the Caloosahatchee Estuary

	In Estuary			Outside the Estuary		
	No.	Size range (mm.)	Salinity range	No.	Size range (mm.)	Salinity range
October				495	16-22	26.5-33.6
December	13	21-22	9.8	453	21-25	19.8-32.4
January	1032	24-39	0.14-28.4	379	24-32	6.6-34.1
March	160	21-36	0.22- 3.4	1	28	28.7
May	209	36-98	0.17-11.0	1	89	35.7
June	9	54-133	0.09-11.0			

Atherinidae

Membras martinica (Valenciennes), Rough silverside

Springer and Woodburn (1960) have raised some doubt about the proper terminology of this species, but until the matter is clear we continue to use the name.

Fifteen specimens were taken in 3 hauls at SS 3 and 4 in May 1957 and 1958. The total lengths ranged from 23-65 mm., and the salinities were 1.8, 15.8 and 31.2. Outside the Estuary, at SS 5, 28 fish were taken on 22 May 1958. The salinity was 30.1. Springer (1960) reported 1 fish just outside the Estuary and 2 inside as *Membras* sp.

Menidia beryllina (Cope), Silverside

In Texas waters Gunter (1945) reported 10,006 specimens from bay waters and 48 from the Gulf beach. During this work we took 3,005 in seines within the Estuary itself and 195 outside. Springer and Woodburn (1960) reported sporadic catches on the Gulf beach at Pass-à-Grille, but did not give the figures.

This fish was taken at all seasons and at all inside seine stations, but only 89 were taken at SS 4. On the outside only one catch was made on the Gulf beach at SS 8 on 1 December 1959. Table 9 gives the catches and size ranges for the various months with the different years combined.

Gunter (1945) noted evidence of two major spawning peaks in Texas waters, which Springer and Woodburn confirmed for the Tampa area with the additional observation that there was some evidence of a third peak. Table 9 shows that fish less than 20 mm. long were taken in March, May and June, and the appearance of the young caused a great increase in population. Evidently the chief spawning period is in the spring and early summer. This corresponds to the data presented by Springer and Woodburn. Fish with running eggs and milt were taken in March and June. Fish 20 and 22 mm. long were taken in September, December and January, giving some indication of an additional spawning peak in the fall. Specimens greater than 80 mm. long were taken in January, March, October and December.

Table 8

Summary of all catches of *Mugil curema*

Station No.	No. taken	Length range (mm.)	Date	Salinity
Inside the Estuary				
2	9	58-74	13 May 57	11.0
3	1	17	13 May 57	15.8
5	1	14	2 June 60	17.6
Outside the Estuary				
5	1	11	13 May 57	34.2
5	55	20-30	22 May 58	30.1
7	2	113-172	25 Sept 57	17.5
8	3	19-21	14 May 27	37.5
8	2	20-27	22 May 58	35.5
8	61	one 133 sixty 17-19	2 June 60	33.7

The very largest specimens seemed to disappear at about the time of the first spawning peak of the year.

Calculations from Gunter's (1945) Table 7, show that the 10,054 specimens he caught in Texas were at a mean salinity of 17.5. In Caloosahatchee waters the mean salinity where this species was caught, obtained by weighting salinities by the numbers caught, was 3.5. The reason for this discrepancy is unknown. In any case the species is euryhaline, and it may be said that some factor other than salinity determines its distribution.

Table 9

Catches of *Menidia beryllina* in the Caloosahatchee area, May 1957-June 1960

(Months for the various years are combined)

	In the Estuary		Outside the Estuary	
Month	**Total length (mm.)**	**Number**	**Total length (mm.)**	**Number**
January	22-81	81	69-94	20
March	26-85	176	16-97	33
May	18-74	768	30-57	12
June	13-68	842	30-66	27
September	21-62	99	44-70	39
October	24-87	308	68-70	2
December	22-90	731	20-87	62

Springer (1960) reported hundreds of specimens just outside the Estuary and others within it in 8 hauls made in 1958 and 1959. Insofar as he gave two hauls as "hundreds" we cannot compare weighted salinities, but the range was 0.4 to 33.2 and the average for each haul is 16.4. The salinities at the "hundreds" hauls were 32.9 and 33.2 and the mean at which his specimens were caught was even higher than Gunter (1945) reported in Texas.

Labidesthes sicculus (Cope), Freshwater silverside

Fourteen specimens were taken at SS 1 on 1 December 1959. The length range was 30-45 mm. and the salinity was 0.12.

Serranidae

Diplectrum arcuarium Ginsburg

Seven specimens, 37-182 mm. long, were taken at TS 7 and 8 on 25 June 1959. The salinities were 23.0 and 24.5.

Diplectrum formosum (Linnaeus), Squirrelfish

Five specimens were taken at Trawl Stations 6, 7, and 8 in May and September 1957 and January 1959. The lengths were 113 to 170 mm. and the salinity range was 18.0-35.0. The mean salinity was 30.2.

Centrarchidae

Enneacanthus gloriosus (Holbrook), Little sunfish

Nine fish, 27-71 mm. long, were taken in 5 hauls at SS 1, 2 and 3 in October 1958 and June and 1 December 1959. Six fish were taken at Stations 1, 2 and 3 on the latter date. The salinity ranges were from 0.09 to 1.0.

Lepomis microlophus (Günther), Shellcracker

Five fish were caught. One was taken at TS 1 on 2 January 1958. Four were taken at SS 2 on 1 December 1959. The length ranges were 57-128 mm. and the salinities were 0.12-0.22.

Lepomis macrochirus Cope, Bluegill

Two fish were caught at SS 1 and TS 1 on 25 June 1959 and 3 March 1960. The lengths were 51 and 83 mm. The salinities were 0.09 and 0.26.

Carangidae

Caranx hippos (Linnaeus), Common jack

Two jacks were taken on the Gulf beach of Sanibel Island on 22 May 1958. The lengths were 208 and 218 mm. The salinity was 35.5. Another fish, 170 mm. long was taken at TS 7 on 30 January 1958. The salinity was 24.8.

Chloroscombrus chrysurus (Linnaeus), Yellowtail

One fish 72 mm. long was taken at TS 7 on 25 September 1957. The salinity as 32.2.

Oligoplites saurus (Bloch and Schneider), Leatherjacket

Two fish, 63 and 167 mm. long, were taken in June 1959 and September 1957 at SS 5 and 8. The salinities were 9.5 and 27. 6.

Trachinotus carolinus (Linnaeus), Pompano

Fifteen pompano were taken on the Gulf beach of Sanibel Island (SS 8) in May and October 1958 and June 1960. The salinities ranged from 33.6 to 35.5. In May 2 fish were 19 and 224 mm. long, and in June 10 fish were 18-46 mm. long and in October the lengths of 3 fish were 61-63 mm.

Springer and Woodburn took 59 young specimens and reported 9 others all from the Gulf beach and collected in June, July and August.

On the northern Gulf beaches the young of the common pompano are among the most abundant fishes in summer months, being exceeded only by *Harengula pensacolae*. In contrast Springer and Woodburn and the writers found young pompano only in small numbers on the Gulf beaches off Tampa Bay and the Caloosahatchee.

Trachinotus falcatus (Linnaeus), Round pompano

Forty specimens, 16 to 125 mm. long, were taken at SS 6, 7 and 8 in June, September and October. They were more abundant than *T. carolinus*, as Springer and Woodburn previously noted for the Tampa area, but we took only 3 on the Gulf beach on 27 September 1957. They were 50-125 mm. long. Five fish taken on the bay side of Sanibel Island on 2 June 1960 were 16-25 mm. long. Twenty-nine fish taken there on 2 October 1958 were 19-62 mm. Three fish were taken at SS 6, which was abandoned after that haul, on 25 September 1957. They were 39-69 mm. long.

As Springer and Woodburn noted, the young appear at about the same time as young *T. carolinus*. However, young *T. falcatus* are found at lower salinities. The mean salinity for the catch of the common pompano was 33.9; for the round pompano it was 30.0. This does not appear to be great, but the salinity range for *T. falcatus* was 17.5-31.8, and this was reflected in a predominantly bay distribution.

Springer and Woodburn called attention to the yellow fins of young *carolinus* and the bright orange fins of *falcatus*. There are additional differences in dark color of the smaller specimens. In *carolinus* there is sometimes a dark gray or blackish splotching on the body. In *falcatus* the color is darker and much more extensive so that the little fish may appear to be almost totally black. This color changes with the angle of the light and a black fish may appear silvery as it is turned in the hand. All colors fade rapidly in formalin.

Centropomidae

Centropomus undecimalis (Bloch), Snook

One snook, 34 mm. long was taken at SS 1 on 13 May 1957. The salinity was 3.3. Another 307 mm. long was taken at SS 3 on 25 June 1959. The salinity was 0.09.

Lutjanidae

Lutjanus griseus (Linnaeus), Gray snapper

Three gray snappers were taken at TS 4, the lower Estuary, on 13 May 1957. They were 69-75 mm. long. The bottom salinity was 33.0.

Lutjanus synagris (Linnaeus), Lane snapper

Twenty-four specimens were taken outside the Estuary. A fish 33 mm. long was taken at SS 5, Punta Rassa, on 30 October 1958. The salinity was 26.5. A total of 23 fish was taken at TS 7 and 8. In view of the sparse life history information on this snapper the catch data are given:

Month	Number	Length range (mm.)	Salinity
May 1957	1	158	35.0
September 1957	19	85-125	32.2-34.0
October 1958	2	91-113	30.5
December 1959	1	42	26.6

The mean salinity at which this snapper was taken was 31.9.

Pomadasyidae

Orthopristis chrysopterus (Linnaeus), Pigfish

Seventy-four pigfish were taken outside the Estuary, six at SS 5 and 7 in June 1959 and 1960 and 68 at all trawl stations and during all months except March and December. The seined specimens were 40-60 mm. long and the trawled fish were 57-194 mm. long. Fish 70 mm. long and less were taken only in May and June. Fish 180 mm. in length and longer were taken only in June and September. Thirty-eight fish, over half, were taken in June. Springer and Woodburn took over half of their specimens in June and July.

The salinity range of the catches was from 9.5 at a seine station to 32.9 in the trawls. The mean salinity was 24.9.

Springer (1960) took a specimen 18.4 mm. in standard length just outside the Estuary in May 1959.

Gerridae

Diapterus plumieri (Cuvier), Mojarra

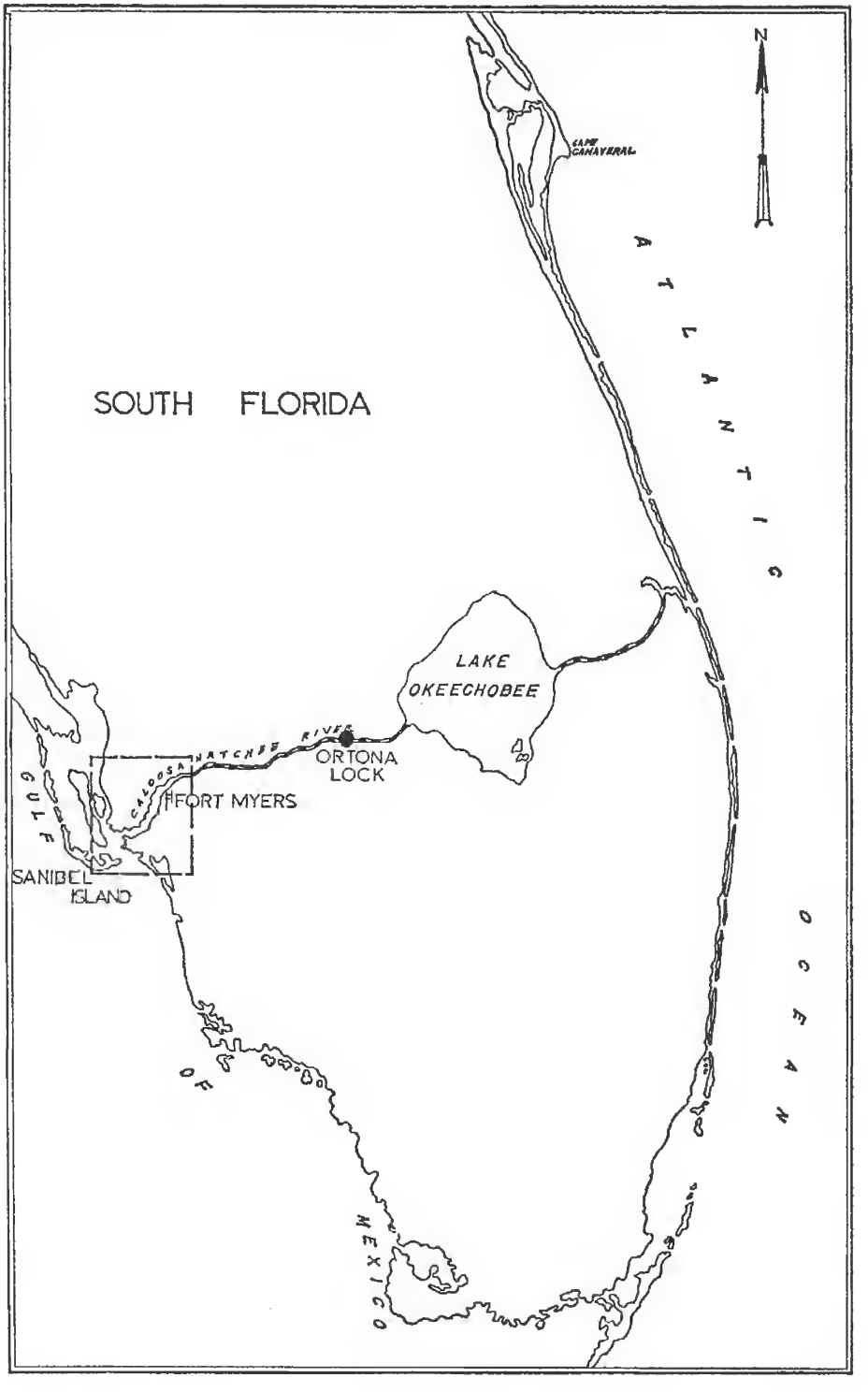
One fish, 82 mm. long, was taken on 13 May 1957 at TS 1, in the Estuary. The salinity was 3.3. A specimen 84 mm. long was taken on the same date at Seine Station 4. The salinity was 3.4. Two fish, 205 and 276 mm. long, were taken at SS 3 on 1 December 1959. The salinity was 3.4. No specimens were taken outside the Estuary. We believe that this species is different from the one in the St. Lucie, which we call *D. olisthostomus.*

Eucinostomus argenteus Baird and Girard, Sand perch

Four hundred and five specimens were taken both inside and outside the Estuary in all seasons and in both seines and trawls. The combined data are given below:

	Number	Length range (mm.)	Salinities
Seines, Estuary	214	26-100	0.20-15.8
Trawls, Estuary	61	53-109	0.24-0.56
Seines, Outside	70	12- 88	14.8-32.4
Trawls, Outside	60	71-112	25.0-32.2

PLATE NO. 1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SOUTH FLORIDA
LAKE OKEECHOBEE
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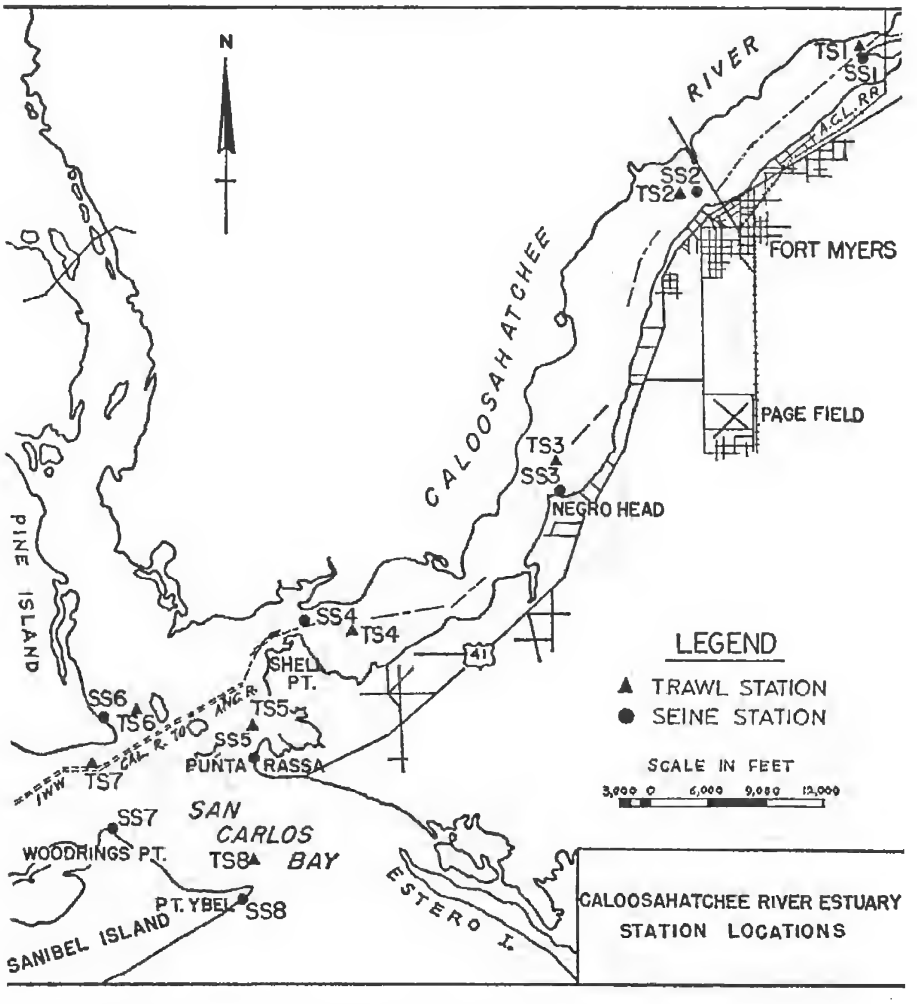
FORT MYERS
GULF
SANIBEL ISLAND
OF
MEXICO
OCEAN

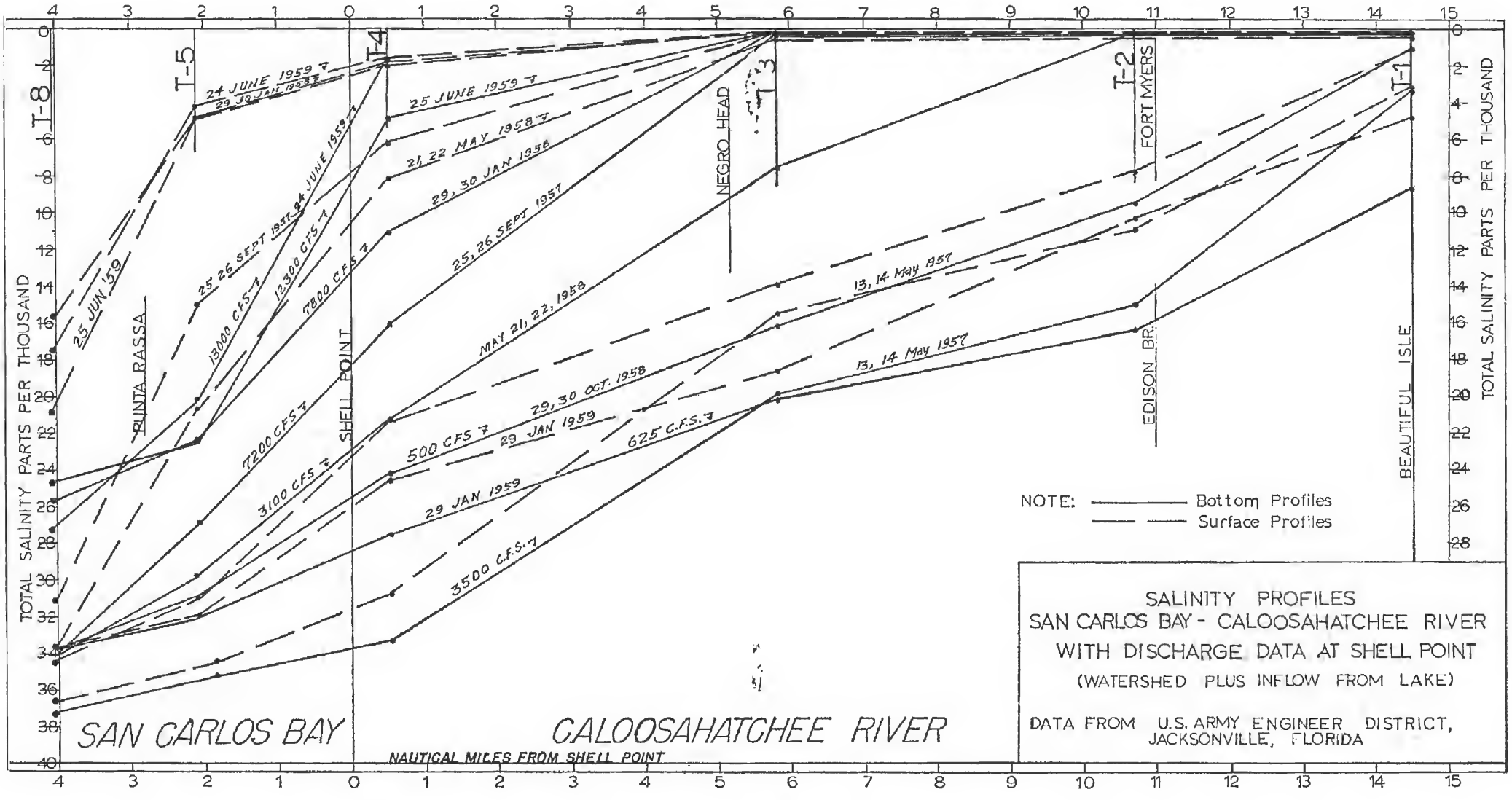
Plate No. 2



ABOVE—Caloosahatchee Estuary with pertinent reference points.

AT LEFT—Location of area under consideration and its relation to the overall Project.

Plate No. 3



Bottom and surface salinity profiles for Estuary and outer bays.

The numbers taken by months and the sizes were as follows:

	Inside		Outside	
	Number	**Length (mm.)**	**Number**	**Length (mm.)**
January	1	85	5	90-104
March	2	94-101	6	67- 84
May	15	26-100	2	74- 88
June	14	57- 97	-	-
September	-	-	55	69-103
December	246	27-109	62	12- 97

Springer and Woodburn found the smallest fish in October, November and again in June. We took them in December. We again took somewhat small fish in May. There is nothing similar in their curves for either species of *Eucinostomus*, and the matter cannot be attributed to confusion of the species. Our largest fish were taken in January and September. Theirs were taken in April and October.

Springer and Woodburn give the salinity range at which both species of *Eucinostomus* are caught as 3.7-25.1 but stated that *E. gula* is usually taken at the higher salinities, generally 24-32. The mean salinity at which we recorded *E. argenteus* was 9.4. Springer (1960) reported 30 specimens taken in May 1958 and February from the same area. His May fish were taken at a mean salinity of 15.5; ours were taken at a mean salinity of 12.1.

Eucinostomus gula (Cuvier), Silver mojarra

The mojarra was taken in all seasons both inside and outside but catches in March and May were very small. A total of 545 specimens were caught. The catches by months were as follows:

	Outside			Inside		
Months	**No.**	**Length range (mm.)**	**Salinity range**	**No.**	**Length range (mm.)**	**Salinity range**
January	139	41-137	6.6-32.1	32	33- 95	1. 6-28.4
March	6	63- 84	30.02	1	47	0.29
May	3	63- 90	30.1	-		
June	51	25-102	8.5-28.7	50	21- 70	0.09-<1.0
September	66	64-103	18.0-28.8	88	14- 76	0.17-11.1
October	44	12-116	26.5-33.6	48	16- 96	<1. 0-26.3
December	17	24- 70	19.8-32.4			
	326			219		

Fish less than 20 mm. long were taken in September and October. Fish longer than 100 mm. were all taken outside the Estuary in January, June, September and October, the very largest being taken in January.

The salinities at which this species was taken ranged from 0.09 to 33.6. The mean weighted salinity at which the species was caught was 13.9.

Springer (1960) caught 55 *E. gula* outside the Estuary, but none inside.

Sciaenidae

Bairdiella chrysura (Lacépède), Yellowtail

One hundred and seventy-five fish were taken outside the Estuary and 105 were caught inside. The monthly records are as follows:

	Estuary			Outside		
	No.	**Length range (mm.)**	**Salinity range**	**No.**	**Length range (mm.)**	**Salinity range**
January	2	98-103	8.6-16.4	13	109-136	22.3
March	8	117-140	3.5-12.6			
May	3	32- 42	3.3	72	10- 57	34.2
June	160	32-147	11.4	20	36- 95	22.5-26.0
October	2	92-132	7.3			

The salinity range at which the fish was caught was 3.3-34.2 and the mean salinity was 18.3.

The smallest fish were taken in May and the greatest number were taken in June. These data and the salinity range correspond very closely to that reported by Springer and Woodburn. They reported largest specimens in December, February and March; ours were taken in March and June.

Leiostomus xanthurus Lacépède, Spot

Ninety fish were taken in seines in the Estuary and 234 were taken in seines outside; 406 were taken in trawls in the Estuary. The seined fish in the Estuary were 18-74 mm. long and those from the outside were 25-101 mm.; the trawled fish were 29-158 mm. long. Six fish 180-230 mm. long were taken in a trawl haul in June 1959 outside the Estuary. The catch data by months were as follows:

	Inside			Outside		
Months	**No.**	**Lengths (mm.)**	**Salinity**	**No.**	**Lengths (mm.)**	**Salinity**
January	4	18- 55	0.12- 0.72	28	16- 24	6.6
March	86	23- 47	0.22- 3. 4	203	18- 92	28.7-33.7
May	213	42-157	0.18-21. 2	2	80- 92	30.1
June	213	69-123	0.39-11. 4	7	87-230	23.0-28.7

Smallest fish were taken in January and March. The table shows that the small fish appeared first on the outside. For instance 213 fish 15-29 mm. long were taken at SS 7 and 8 on 2 March 1960. The fish then moved inside and the outside populations diminished greatly in May and June. Peculiarly, no fish were taken between June and January. Springer and Woodburn took no fish at most of their stations after July or August until January or February. Kilby (1955) found no spots in the marshes at Cedar Keys after June, somewhat similar to what we found in the Caloosahatchee Estuary.

The mean salinity at which specimens were caught was 11.0. Springer (1960) reported 198 spots taken in May and February at a mean salinity of 15.0.

Menticirrhus americanus (Linnaeus), Whiting

One hundred and forty specimens were taken. The fish was not abundant and catches were made only in January, May, June and December. The smallest fish were taken in May and June, which corresponds with what has been learned previously about the spawning of this fish. The catches were as follows:

	Inside			Outside		
Month	**No.**	**Length (mm.)**	**Salinity**	**No.**	**Length (mm.)**	**Salinity**
January	1	260	16.4	3	207-310	24.8
May	22	28-252	7.5-21.2	1	33	37.5
June	2	34-100	11.4	105	25-101	26.5
December				7	32- 57	19.8-32.4

The greatest numbers were taken in May and June when the young fish were coming in, and in fact over 92 per cent of the catch was made then. The mean salinity at which the species was taken was 25.1. Springer (1960) reported one fish from the Caloosahatchee in May 1958.

Menticirrhus focaliger Ginsburg, Gulf whiting

No specimens were taken in the Estuary. One was taken at TS 7 on 2 December 1959. Eighty-two were taken in outside seine hauls, all but 7 on the Gulf beach of Sanibel Island.

Springer and Woodburn took their smallest specimens in October and November. Our smallest fish, 17 mm. total length, was taken in December, but we also took small fish, 23 mm., in June, which also corresponds with the statement of Springer and Woodburn that there is "some evidence that spawning is concurrent with that of the other two species - - - ." So there is a question concerning the breeding season of this fish which remains unresolved. The catch records were as follows:

Month	**Number**	**Length range (mm.)**	**Salinities**
January	11	31- 72	29.1
March	8	24- 90	28.7-33.7
June	56	23-113	17.6-33.7
December	8	17- 43	19.8-32.4

The mean salinity at which the fish was caught was 32.0.

Springer (1960) reported 3 fish from outside the Estuary.

Small fish on the Gulf beach are often a light silvery color and are easily confused with *M. littoralis*, but the characteristic species markings may be seen as the fish is turned in the light.

Menticirrhus littoralis (Holbrook), Silver whiting

One hundred and thirty-eight fish were taken on the Gulf beach of Sanibel Island and no others were caught. It is well known that this fish is found mostly on the sandy sea beach and is taken very rarely in the bays. The catch records were as follows:

	Number	Length (mm.)	Salinities
January	1	62	34.1
May	129	25-125	33.5-37.5
June	2	27- 29	33.7
October	4	22-152	33.6
December	2	61- 66	32.4

A rather long spawning season is indicated by the size of the smaller fish from May to October.

Micropogon undulatus (Linnaeus), Croaker

A total of 262 croakers was caught. One little one, 16 mm. long, was taken at SS 5 (Punta Rassa) on 29 January 1959 at a salinity of 3.2. The remainder were taken in the Estuary, 130 in seines and 131 in trawls. The catches were as follows in the Estuary:

	Number	Length (mm.)	Salinities
January	114	12- 88	6. 1-28.4
March	47	42- 82	0.26- 3.5
May	99	72-120	0.18- 7.5
June	3	120-146	2. 0-11.4

The smallest fish taken in the trawls was 48 mm. long. Ninety-six croakers 13-24 mm. long were taken in January 1959 in the seines. Gunter (1945) noted the influx of small croakers between November and February into Texas inside waters.

The croaker is not abundant in the Caloosahatchee area, as Springer and Woodburn also noted for Tampa Bay.

Springer (1960) took 37 croakers in the middle part of the Estuary at a mean salinity of 7.6. During our survey the mean salinity for the catch of croakers was 8.8.

Pogonias cromis (Linnaeus), Black drum

One black drum, 147 mm. long, was taken outside the Estuary at TS 5 on 25 June 1959. The salinity was 22.5.

Sciaenops ocellata (Linnaeus), Red drum

A total of 213 red drum was taken, 5 in seines outside, 2 in trawls and 206 in seines in the Estuary. The monthly catches were as follows:

	Estuary			Outside		
	No.	Length (mm.)	Salinity	No.	Length (mm.)	Salinity
January	1	72	0.14			
March	5	47-132	0.29-0. 4			
May	1	109	0.18			
December	201	21- 44	0.20	5	17-32	24.7-32.4

The large number of young fish taken in December must have derived from a late fall spawning, which has been reported by several workers elsewhere. Springer (1960) reported large numbers of young redfish within the Estuary in February 1959. He took 35 fish at a mean salinity of 13.3. Our specimens, which included many young within the fresh water range, were taken at a mean salinity of 0.9.

Cynoscion arenarius Ginsburg, White trout

All specimens were taken in trawls, one outside the Estuary at TS 7 on 25 June 1959. It was 155 mm. long and the salinity was 23.0. One hundred white "trout" were taken in the Estuary as follows:

	Number	Lengths (mm.)	Salinities
January	4	110-126	8. 6
May	68	31-209	0.18-21. 2
June	19	34-120	0.09- 2. 0
September	7	68-136	0.23
December	2	75- 88	0.24

As Springer and Woodburn (1960) noted, the absence of very young forms in the estuarine waters argues against the idea of bay spawning as suggested by Reid (1955), and we believe they are correct in assuming that the species spawns in the Gulf, possibly in April and May in the Caloosahatchee area.

It is well known that adults of this species go far into the Gulf. Our specimens were taken at a mean salinity of 5.8.

Springer (1960) took 4 fish within the Estuary.

Cynoscion nebulosus (Cuvier), Speckled trout

All fish were taken in outside waters. One was taken in a trawl on 25 June 1959. It was 198 mm. long. Thirteen fish were taken in seines at Punta Rassa and on the inside of Sanibel Island in the months of June and October. Nine June specimens were 23-47 mm. long; four October fish were 26-36 mm. long. The salinity range for this fish was 9.5-31.8 and the mean salinity was 22.7.

This fish is generally of estuarine distribution but the senior author has noted that it is not usually found in turbid waters, which possibly explains its absence from the Caloosahatchee Estuary.

Sparidae

Archosargus probatocephalus (Walbaum), Sheephead

One sheephead, 135 mm. long, was taken in the lower Estuary at TS 4 on 2 March 1960. The salinity was 12.6.

Lagodon rhomboides (Linnaeus), Pinfish

Four hundred and ninety-seven pinfish were caught as follows:

	Inside		Outside	
	Trawls	Seines	Trawls	Seines
Number	33	51	76	337
Lengths	20-125	16-110	70-185	15-153
Salinity	0.12-16.0	0.09-28.4	18.0-35.2	6.6-37.5

Months	Number	Lengths (mm.)	Number	Lengths (mm.)
January	14	16-20	43	20-144
March	3	23-27	20	15-42
May	18	38-70	129	24-185
June	46	24-93	178	25-145
September	1	125	32	98-162
October	2	106-110	8	98-148
December			3	larvae

We found the very smallest fish in December, as Springer and Woodburn noted for Tampa, and small fish continued to come in during January. Large fish were taken during all months but March, but none of these approached the maximum size for this species.

The salinity range was 0.09 to 37.5 and the mean salinity at which specimens were taken was 25.5.

Springer (1960) reported 95 specimens from the area in 1958 and 1959, of which 61 were taken within the Estuary. The salinity range was 0.4 to 33.2 and the mean salinity was 9.7.

Ephippidae

Chaetodipterus faber (Broussonet), Spadefish

One fish was taken within the Estuary at TS 4, on 25 September 1957. Eight fish were taken in trawls outside the Estuary. Five of the latter were 62-67 mm. long. The others ranged from 83 to 103 mm. long. The salinities ranged from 18.0-35.0, and the mean salinity at which the spadefish was caught was 23.0.

Uranoscopidae

Astroscopus y-graecum (Cuvier), Stargazer

Three fish, 34-39 mm. long, were seined on the bay shore of Sanibel Island on 2 March 1960 at a salinity of 28.7. This compares well with the 2 specimens 31.4 and 34.0 mm. SL which Springer and Woodburn took in Tampa Bay in February. Probably this stargazer spawns in December or January.

Gobiidae

Gobiosoma bosci (Lacépède), Naked goby

Twenty-two of these little gobies were taken in the Estuary, six in trawls and 16 in seines. The catches were as follows:

Month	Number	Lengths (mm.)	Salinities
January	8	24-52	0.12- 6. 1
March	2	42-44 (with eggs)	0.26- 0.29
May	2	26-27	3. 3-33. 0
June	5	18-47	0.09- 9. 0
October	3	22-40	7. 3
December	2	32-33	0.20

One specimen in March had yellow eggs. Probably the spawning season is long. The salinity range was quite broad, but the mean salinity at which this goby was caught was 4.2. Springer (1960) took 107 naked gobies in the Caloosahatchee at 4 stations, 95 at one station. The mean salinity for his catches was 9.6.

Gobiosoma longipala Ginsburg, Florida naked goby

Fifteen specimens were taken. Thirteen specimens were taken at TS 7 and 8 between 22 May 1958 and 2 March 1960. They were 26-41 mm. long and the salinity range was 25.6-32.9. This little goby was found often in *Cerebratulus* tubes. One specimen 31 mm. long was seined on the bay beach of Sanibel Island on 2 June 1960. The salinity was 28.7. One specimen is listed in our records as being taken

at SS 1 in the Estuary at a salinity of 1.0 on 29 October 1958. It was 36 mm. long. The station is disjunct from the others and the salinity is very low. Possibly there was some confusion in the records, but there is nothing to indicate it. This specimen and several others are in the Gulf Coast Research Laboratory collection.

This species seems to be a cognate of *Gobiosoma ginsburgi* of the middle Atlantic, and in fact was first identified as that species. The above specimens are the only ones reported since Ginsburg described the species, except for the one taken by Springer (1961) in Tampa Bay on 22 November 1960. This goby is probably a common habitant of sheltered, high salinity bays on the southern Florida Gulf coast, especially in deeper waters away from the shore. (Since the above was written Dawson (1963) has recorded this species as far west as Mississippi.)

Gobionellus boleosoma (Jordan and Gilbert), Pygmy goby

Two fish were taken in the upper Estuary at TS 1 on 29 January 1958 and 29 January 1959. One was 43 mm. long and the other was not measured. The salinities were 0.12 and 8.6.

Microgobius gulosus (Girard), Largemouth goby

Twenty-seven specimens were taken. One was caught at Seine Station 7 on 22 May 1958 at a salinity of 32.9. All others were taken in the Estuary, 8 in trawls and 18 in seines; the monthly records were as follows:

Month	Number	Length (mm.)	Salinities
January	3	31-44	11.1
March	7	41-72	0.26- 3.4
May	7	30-46	0.18- 3.3
June	3	47-56	0.9
October	6	22-51	1. 0- 7.3

The mean salinity for the catches of this species was 4.3.

Springer (1960) took one fish just outside the Estuary and 27 inside at a salinity range of 0.9 to 33.2 and a mean salinity of 3.5.

Scorpaenidae

Scorpaena plumieri Bloch, Scorpionfish

One specimen, 153 mm. long, was taken at TS 7 (San Carlos Bay) on 25 September 1957. The salinity was 32.2. Apparently the species has not been reported previously from the Caloosahatchee or Tampa areas.

Triglidae

Prionotus tribulus Cuvier, Sea robin

Eighteen sea-robins of this species were taken, five in seines and 2 in trawls in the Estuary and 2 in seines and 9 in trawls outside. The monthly catches were as follows:

	Inside			Outside		
Month	No.	Length range (mm.)	Salinity	No.	Length range (mm.)	Salinity
January	1	88	16.4	2	43 -44	22.3-25.6
May	1	35	9.4			
June				9	33-160	23.0-33.0
October	5	26-34	<1.0- 7.3			

Springer and Woodburn said young appeared in late fall and winter. Our smallest ones were taken in October but some rather small fish were also taken in May and June.

The mean salinity at which the species was caught was 18.2.

Prionotus scitulus Jordan and Gilbert, Long sea robin

Twenty-five of these sea robins were caught in trawls outside the Estuary as follows:

Month	Number	Length range (mm.)
January	7	110-210
May	3	125-145
June	6	40-143
September	4	107-157
October	2	115-132
December	3	103-152

The salinity range at which the fish were taken was 18.0-34.0 and the mean salinity was 25.4.

Springer (1960) took 2 specimens just outside the Estuary on 11 February 1959. They were 17-29 mm. SL. The salinity was 33.2.

Batrachoididae

Opsanus beta (Goode and Bean), Oysterdog

Two fish, 180-201 mm. long were taken in the lower Estuary, TS 4, on 25 June 1959. The salinity was 4.9. Three other specimens were taken at TS 5, 7 and 8 in May and September 1957 and May 1958, at lengths of 53, 93 and 85 mm. and salinities of 35.2, 32.2 and 34.2, all respectively.

Springer (1960) reported one fish just outside the Estuary in February 1959.

Porichthys porosissimus (Cuvier), Midshipman

One fish 165 mm. long was taken in San Carlos Bay, TS 7, on 25 June 1959. The salinity was 23.0.

Gobiesocidae

Gobiesox strumosus Cope, Clingfish

One specimen was taken in the lower Estuary at TS 4 on 13 May 1957. It was not measured. The salinity was 33.0.

Aluteridae

Stephanolepis hispidus (Linnaeus), Filefish

Three filefish were taken in seines and 5 in trawls outside the Estuary during the months of January, June, September, October and December. One fish taken in January was 74 mm. long, and the others were 13-28 mm. long with the smallest occurring in June. The salinity range was 23.0-33.7 and the mean was 29.1. This corresponds closely to the salinity range given by Springer and Woodburn for 125 filefish taken in the Tampa region.

Ostraciidae

Acanthostracion tricornis (Linnaeus), Cowfish

Five cowfish were taken in 5 trawl hauls outside the Estuary during the months of January, May, June and September. The total length range was 90-237 mm., the mean being 142 mm. The salinity range was 23.0-33.7 and the mean was 29.2.

Tetraodontidae

Sphoeroides nephelus (Goode and Bean), Puffer

One puffer, 85 mm. long, was taken at Trawl Station 8 in January 1959. Seven others were taken at the bay Seine Stations 5, 7 and 8 in January, October and December. Their length range was 16-44 mm. The smallest specimen was taken on the Gulf Beach of Sanibel Island on 30 October 1958. The salinity range was 19.8-33.7.

Springer (1960) took one fish just outside the Estuary in February 1959.

Diodontidae

Chilomycterus schoepfi (Walbaum), Porcupinefish

One little fish, 22 mm. long, was taken at the Punta Rassa seine station on 13 May 1957. The salinity was 34.2. Twenty others were taken in outside trawl hauls as follows:

	Number	Length range (mm.)	Salinity
January	3	98-104	25.6
June	2	115-120	23.0
September	2	105-185	32.2
October	3	38-125	30.8-33.8
December	10	80-220	26.6

The mean length of the trawled fish was 128 mm. The mean salinity for all specimens was 27.9.

Springer (1960) took 2 boxfish just outside the Estuary in February 1959.

Ogcocephalidae

Ogcocephalus sp., Batfish

Two batfish, both 120 mm. long, were taken at TS 6 and 8 in May 1957 and June 1959. The salinities were 31.2 and 24.5.

Heterosomata

Bothidae

Etropus crossotus Jordan and Gilbert, Whiff

Two fish were taken in the lower Estuary and 8 were taken outside in trawls during the months of January, June, September and October. The length range of the fish was 61-105 mm. and the salinity range where they were caught was 18.0-33.7. The mean salinity was 26.0

Paralichthys albigutta Jordan and Gilbert, Gulf Flounder

One fish, 173 mm. long, was taken outside the Estuary at TS 5 on 2 December 1959. The salinity was 25.0. Springer (1960) took 5 specimens outside the Estuary in 1958 and 1959.

Paralichthys lethostigma Jordan and Gilbert, Flounder

Two fish, 173 and 200 mm. long, were taken outside the Estuary at TS 5 and 7 on 30 October 1958. The salinities were 30.8 and 30.5.

Soleidae

Achirus lineatus (Linnaeus), Sole

A fish 51 mm. long was taken in the Estuary at TS 3 on 3 January 1958. The salinity was 0.14. Outside catches consisted of a 36 mm. fish taken on 2 March 1960 at SS 7, where the salinity was 28.7, and a 49 mm. specimen from Trawl Station 8 on 25 June 1959, where the salinity was 22.5.

The body outline of this fish is much rounder than *Trinectes maculatus*, especially at smaller sizes, and the two are easily separable on this basis as far as they can be seen clearly.

Trinectes maculatus (Bloch and Schneider), Hogchoker

Four hundred and thirteen specimens were taken in trawls, of which only 8 were taken outside the Estuary at TS on 25 June 1959. The monthly catches of all specimens are given below:

	Number	Length range (mm.)	Salinity range
January	160	27-113	0.12-16. 4
March	127	12- 79	0.26- 0.33
May	10	50- 69	0.18
June	68	37-122	0.09-22. 5
September	11	24- 70	0.17
October	26	57- 96	<1. 0-16. 1
December	11	38- 85	0.19- 0.24

The mean salinity at which specimens were caught was 1.98.

Springer (1960) took 9 specimens within the Estuary in May 1958. The size range was 29-57 mm. SL. The salinity range was 0.1-1.3 and the mean was 0.93.

Cynoglossidae

Symphurus plagiusa (Linnaeus) Tonguefish

Six tongue soles were caught, one in seines and 3 in trawls in the Estuary and 2 in trawls outside, in the months of January, May, June, September and October. Two fish 61 and 70 mm., taken in October and January, were the only ones less than 100 mm. long. The others ranged from 107 to 120 mm. The salinity range was 7.3-27.5 and the mean was 20.5.

Springer (1960) took 3 fish just outside the Estuary and 4 inside in February 1959. The salinity range was 10.7 to 33.2 and the mean was 22.8.

Table 10

The total fishes caught by trawls within the estuary

Species	Number	Total length range (mm.)	Salinity range (p.p.t.)
Dasyatis sabina (LeSueur)	1	300 (disks)	0.09
Elops saurus	19	58-125	0.18- 2.00
Harengula pensacolae	1	55	24. 1
Dorosoma petenense	3	39-100	0.18
Anchoa hepsetus	15	46- 68	11. 4
Anchoa mitchilli	608	20- 77	0.18-21. 2
Synodus foetens	3	70-221	11. 4-27. 5
Galeichthys felis	548	85-300	0.09-19. 8
Bagre marina	2	102-107	0.17-19. 8
Ictalurus catus	6	31-152	0.09- 0.26
Ictalurus punctatus	2	95-121	0.18- 0.26
Lucania parva	4	31- 35	0.12
Fundulus grandis	1	25	0.18
Heterandria formosa	1	14	0.26
Lepomis macrochirus	1	83	0.26
Lepomis microlophus	1	57	0.12
Lutjanus griseus	3	69- 75	33. 0
Diapterus olithostomus	1	82	3. 3
Eucinostomus argenteus	62	53-109	0.16- 0.26
Eucinostomus gula	3	66- 91	8. 6-27. 5
Bairdiella chrysura	170	32-147	3. 5-16. 4
Leiostomus xanthurus	406	29-157	0.12-21. 2
Menticirrhus americanus	25	28-252	7. 5-21. 2
Micropogon undulatus	133	48-146	0.18-11. 4
Sciaenops ocellata	2	72-109	0.14- 0.18
Cynoscion arenarius	100	31-209	0.09-21. 2
Archosargus probatocephalus	1	135	12. 6
Lagodon rhomboides	33	59- 76	0.12-16. 0
Chaetodipterus faber	1	152	16. 0
Gobionellus sp.	2	43	0.12- 8. 6
Gobiosoma bosci	6	27- 52	0.12-33. 0
Microgobius gulosus	8	41- 56	0.26- 0. 9
Prionotus tribulus	2	35- 88	9. 4-16. 4
Opsanus beta	2	180-211	4. 9
Gobiesox strumosus	1	-	33. 0
Achirus lineatus	1	51	0.14
Trinectes maculatus	405	12-113	0. 9-16. 4
Symphurus plagiusa	3	70-118	19. 8-27. 5
Etropus crossotus	2	105	24. 1-27. 5
Total	2,588		

Table 11

The total number of fishes caught at seine stations in the estuary

Species	Number	Total length range (mm.)	Salinity range (p.p.t.)
Lepisosteus platyrhynchus	1	640	0.26
Elops saurus	3	62-117	0.55- 0.65
Harengula pensacolae	303	48- 77	26. 3
Brevoortia patronus	1	45	3. 3
B. smithi	17	25- 38	1. 9
A. mitchilli and A. hepsetus (mixed)	601	17- 37	1. 6-11. 1
Anchoa mitchilli	1,176	16- 79	0.14-28. 4
A. hepsetus	10	58-110	1. 8-11. 1
Galeichthys felis	15	62- 69	0.17
Noturus leptacanthus	1	23	0.22
Strongylura sp.	21	34-285	1. 9-26. 3
Strongylura notata	4	52-425	0.55-31. 2
Lucania goodei	4	19- 29	0.20
L. parva	290	17- 45	0.09- 6. 1
Fundulus chrysotus	6	29- 39	0.12- 0.22
F. confluentus	1	37	0.13
F. seminolis	48	22-127	0.17- 7. 3
F. similis	5	79- 93	17. 6
Heterandria formosa	21	15- 28	0.12- 0.65
Jordanella floridae	8	15- 23	1. 0- 7. 3
Cyprinodon variegatus	25	17- 42	0.09- 7. 3
Gambusia affinis	1,095	12- 44	0.09- 7. 3
Mollienesia latipinna	70	18- 62	0.13- 7. 3
Cyprinodontid	1	14	3. 3
Syngnathus louisianae	2	119-127	3. 3
Notropis maculatus	36	18- 49	0.09- 0.22

(Continued)

Table 11

(Continued)

Species	Number	Total length range (mm.)	Salinity range (p.p.t.)
N. petersoni	37	28- 54	012- 0.65
Mugil cephalus	1,733	21-133	0.09-28. 4
M. curema	11	14- 74	11. 0-17. 6
Membras martinica	15	23- 65	1. 9-31. 2
Menidia beryllina	3,005	13- 90	0.09-28. 4
Labidesthes sicculus	14	30- 54	0.12
Lepomis microlophus	4	88-128	0.22
Lepomis macrochirus	1	51	0.09
Enneacanthus gloriosus	0	24- 71	0.09- 0.22
Diapterus olithostomus	3	84-276	3. 4-31. 2
Eucinostomus argenteus	216	26-100	0.20-15. 8
E. gula	251	14- 96	0.09-28. 4
Bairdiella chrysura	5	32-132	3. 3- 7. 3
Leiostomus xanthurus	90	18- 74	0.18- 3. 4
Menticirrhus focaliger	3	41- 67	17. 6
Micropogon undulatus	130	13- 68	0.29-28. 4
Sciaenops ocellata	206	21-132	0.20- 3. 4
Lagodon rhomboides	51	16- 65	0.09-28. 4
Centropomus undecimalis	2	34-307	0.09- 3. 3
Microgobius gulosus	18	25- 72	0.18-11. 1
Gobiosoma bosci	16	18- 44	0.09- 7. 3
G. longipala	2	36	0.18
Prionotus tribulus	5	26- 34	1. 0- 7. 3
Symphurus plagiusa	1	61	7. 3
Tadpole	1	-	0.55
Total	9,594		

Table 12

The total number of fishes caught at trawl stations outside the estuary

Species	Number	Total length range (mm.)	Salinity range (p.p.t.)
Anchoa hepsetus	1	49	25.6
Anchoa mitchilli	3	51-65	23.0-24.8
Synodus foetens	10	158-265	18.0-32.9
Galeichthys felis	15	111-207	18.0-25.6
Bagre marina	1	117	18.0
Hippocampus hudsonius	9	13-165	21.4-33.8
Syngnathus louisianae	1	268	24.5
Syngnathus scovelli	1	- -	31.2
Diplectrum arcuarium	7	45-182	23.0-24.5
Diplectrum formosum	6	113-170	18.0-35.0
Chloroscombrus chrysurus	1	72	23.2
Caranx hippos	1	170	24.8
Orthopristes chrysopterus	68	70-194	18.0-32.9
Eucinostomus argenteus	60	71-112	25.0-32.2
Eucinostomus gula	94	35-126	18.0-30.8
Bairdiella chrysura	32	36-136	22.3-23.0
Leiostomus xanthurus	6	180-230	23.0
Menticirrhus americanus	8	40-310	23.0-26.6
Menticirrhus focaliger	1	43	25.0
Pogonias cromis	1	147	22.5
Cynoscion arenarius	1	155	23.0
Cynoscion nebulosus	1	198	22.5
Lagodon rhomboides	76	70-185	18.0-35.2
Chaetodipterus faber	8	62-103	18.0-35.0
Gobiosoma longipala	12	26-41	25.6-32.9
Microgobius gulosus	1	-	32.9
Scorpaena plumieri	1	153	32.2
Prionotus tribulus	9	36-160	22.3-33.0
Prionotus scitulus	25	103-187	18.0-34.0
Opsanus beta	3	53-93	32.2-34.2
Porichthys porosissimus	1	165	23.0
Stephanolepis hispidus	5	13-22	33.0
Acanthostracion tricornis	5	90-237	23.0-33.7
Sphoeroides nephelus	1	85	33.7
Chilomycterus schoepfi	20	38-220	23.0-33.8
Ogcocephalus sp.	2	120	24.5-31.2
Etropus crossotus	8	61-101	18.0-30.5
Citharichthys spilopterus	2	107-110	30.8
Paralichthys albigutta	1	174	25.0
Paralichthys lethostigma	2	173-200	30.5-30.8
Achirus lineatus	1	49	21.4
Trinectes maculatus	8	85-122	22.5-23.0
Symphurus plagiusa	2	112-120	18.0-23.0
Total	521		

Table 13

The total number of fishes caught at seine stations outside the estuary

Species	Number	Total length range (mm.)	Salinity range (p.p.t.)
Harengula pensacolae	223	13-69	26.5-33.7
Opisthonema oglinum	31	58-102	17.5
Anchoa hepsetus	144	27-99	17.5-33.7
Anchoa mitchilli	130	21-71	14.8-35.7
Anchoa sp. larvae	101	-	19.8-34.1
Synodus foetens	9	39-103	28.7
Strongylura timucu	35	55-335	14.8-31.6
Strongylura notata	8	50-340	9.5-35.7
Strongylura sp.	16	72-133	28.7-31.8
Hyporhamphus unifasciatus	3	60-78	30.1
Adinia xenica	1	40	28.7
Gambusia affinis	13	19-36	6.6-28.7
Cyprinodon variegatus	3	33-79	9.5-31.8
Lucania parva	3	22-39	9.5-26.5
Heterandria formosa	2	17	30.2
Mollienesia latipinna	13	25-53	6.6-30.2
Syngnathus scovelli	110	53-109	9.5-34.2
Syngnathus floridae	2	105-112	26.5-31.8
Syngnathus louisianae	9	70-154	28.7-35.5
Mugil cephalus	1,329	16-89	6.6-35.7
Mugil curema	124	11-172	17.5-37.5
Caranx hippos	2	208-218	35.5
Trachinotus carolinus	15	18-224	33.6-35.5
Trachinotus falcatus	40	16-125	17.5-31.8
Oligoplites saurus	2	62-167	9.5-27.6
Lutjanus synagris	1	33	26.5

(Continued)

Table 13

(Continued)

Species	Number	Total length range (mm.)	Salinity range (p.p.t.)
Orthopristes chrysopterus	6	40-60	9.5-28.7
Eucinostomus argenteus	70	12-88	14.8-32.4
Eucinostomus gula	232	12-103	6.6-33.6
Bairdiella chrysura	73	10-65	26.5-34.2
Leiostomus xanthurus	234	15-92	6.6-33.7
Menticirrhus americanus	108	25-101	19.8-37.5
Menticirrhus focaliger	79	17-113	28.7-33.7
Menticirrhus littoralis	138	22-152	32.4-37.5
Micropogon undulatus	1	16	30.2
Sciaenops ocellata	5	17-32	24.7-32.4
Cynoscion nebulosus	13	23-46	0.5-28.7
Membras vagrans	28	39-53	30.1
Menidia beryllina	195	16-97	8.5-34.2
Lagodon rhomboides	337	15-153	6.6-37.5
Astroscopus y-graecum	3	34-39	28.7
Gobiosoma robustum	1	31	28.7
Chasmodes suburrae	1	45	28.7
Prionotus tribulus	2	33-45	28.7
Stephanolepis hispidus	2	22-28	26.5
Sphoeroides nephelus	6	20-44	19.8-33.6
Chilomycterus schoepfi	1	22	34.2
Achirus lineatus	1	36	28.7
			--
Total.....	3,905		--

Table 14

Numbers of fresh-water and salt-water fishes taken at seine and trawl stations within and outside Caloosahatchee Estuary

(Number of species in parentheses)

	ESTUARY STATIONS			BAY AND BEACH STATIONS			ALL STATIONS		
	Fresh water	Salt water	Totals	Fresh water	Salt water	Totals	Fresh water	Salt water	Totals
Seines	1,257 (13)	8,336 (36)	9,593 (49)	13 (1)	3,892 (46)	3,905 (47)	1,270 (13)	12,228 (56)	13,498 (69)
Trawls	13 (5)	2,678 (34)	2,691 (39)	-	521 (43)	521 (43)	13 (5)	3,199 (53)	3,212 (58)
Totals	1,270 (16)	11,014 (51)	12,284 (67)	13 (1)	4,413 (69)	4,426 (70)	1,283 (16)	15,427 (85)	16,710 (101)

Table 15

Salinity average of seine stations and bottom samples at trawl stations, together with numbers of species and numbers of individuals of fresh-water and marine fishes within the Caloosahatchee Estuary and in adjacent outside waters

	Estuary	Bays and beaches
Average salinity (p.p.t.)	6.5	28.1
Salinity range (p.p.t.)	0.1-33.3	6.6-37.5
Number of fresh-water species	16	1
Number of fresh-water fishes	1,270	13
Number of marine species	51	67
Number of marine fishes	11,014	4,413

The Populations of Fishes. — (1) *The general catch and unit of effort.* — The numbers of fishes caught in seines and in trawls within the Caloosahatchee Estuary proper (stations 1 to 4) and in the outside waters (stations 5 to 8, chiefly in San Carlos Bay) are given by species in tables 10 through 13. The two areas were so different in salinity and other characteristics that no purpose would be served in combining these data in one table. The size range and range of salinity at which each species was caught are given.

Table 14 lists the numbers of fresh- and salt-water fishes and the numbers of species caught by each gear in the Estuary and outside waters. It is obvious that marine species dominate both in numbers of species and numbers of individuals, even in the low-salinity Estuary. This information is summarized in table 15.

The average catches of fishes per haul for both types of gear in the estuary and bay waters are given in table 16. The largest catches for both gears were made in the estuary and the seine catches were more than twice as great as trawl catches. This means that the fishes caught were predominantly small or young.

The estuary part of the Caloosahatchee area studied is most similar to the St. Lucie Estuary, which was previously studied and reported upon by Gunter (1959). A comparison of the Caloosahatchee data with similar data on the St. Lucie (*op. cit.*, table 14) shows that the St. Lucie was about 40 per cent richer in the production of fishes, the average catch being 88.8 fish per haul in the Caloosahatchee and 144.9 in the St. Lucie. These two investigations overlapped in time

Table 16

Average catch per haul of fishes taken in trawls and seines inside and outside Caloosahatchee Estuary

	Seines	Trawls	Total
Estuary stations	159.9 (60)	67.2 (40)	122.8 (100)
Bay and beach stations	71.0 (55)	16.3 (32)	50.9 (87)
Grand average catch	117.5 (115)	44.6 (72)	89.4 (187)

Table 17

Total numbers of fishes caught and percentage of total catch for all species with more than 100 specimens—Caloosahatchee Estuary and adjacent waters

Scientific name	Common name	Total No. caught	Percentage of total catch
Menidia beryllina	Silversides	3,200	19.2
Mugil cephalus	Striped mullet	3,062	18.3
Anchoa mitchilli	Bay anchovy	2,619	15.7
Gambusia affinis	Mosquitofish	1,108	6.6
	Subtotal	9,989	59.8
Leiostomus xanthurus	Spot	726	4.4
Galeichthys felis	Sea catfish	681	4.1
Eucinostomus gula	Silver mojarra	580	3.5
Harengula pensacolae	Sardine	527	3.2
	Subtotal	12,513	74.8
Lagodon rhomboides	Pinfish	497	3.0
Trinectes maculatus	Hogchoker	413	2.5
Eucinostomus argenteus	Mojarra	408	2.4
Lucania parva	Rainwater killifish	297	1.8
Bairdiella chrysura	Yellowtail	280	1.7
Micropogon undulatus	Croaker	264	1.6
Sciaenops ocellata	Redfish	213	1.3
Anchoa hepsetus	Striped anchovy	170	1.0
Menticirrhus americanus	Southern kingfish	141	0.8
Menticirrhus littoralis	Gulf kingfish	138	0.8
Mugil curema	Silver mullet	135	0.8
Syngnathus scovelli	Gulf pipefish	111	0.7
Cynoscion arenarius	Sand trout	101	0.6
	Subtotal	15,681	93.8
	80 others	1,029	6.2
	Grand total	16,710	100.0

Table 18

List of fishes caught in Caloosahatchee Estuary and adjacent outside waters by all methods with less than 100 specimens in the total catch

1 SPECIMEN

Dasyatis sabina	Stingaree
Lepisosteus platyrhynchus	Florida spotted gar
Brevoortia patronus	Large-scale menhaden
Adinia xenica	Diamond killifish
Fundulus confluentus	Marsh killifish
Fundulus grandis	Gulf killifish
Noturus leptacanthus	Speckled madtom
Archosargus probatocephalus	Sheephead
Pogonias cromis	Black drum
Chloroscombrus chrysurus	Bumper
Lutjanus synagris	Spot snapper
Porichthys porosissimus	Midshipman
Chasmodes suburrae	Florida blenny
Gobiosoma robustum	Goby
Gobiesox strumosus	Clingfish
Paralichthys albigutta	Gulf flounder
Scorpaena plumieri	Scorpionfish

2 TO 4 SPECIMENS

Dorosoma petenense	Threadfin shad
Hyporhampus unifasciatus	Halfbeak
Bagre marina	Gafftopsail
Ictalurus punctatus	Channel catfish
Lucania goodei	Redfin killifish
Lepomis macrochirus	Bluegill
Syngnathus floridae	Pipefish
Diapterus olithostomus	Striped mojarra
Lutjanus griseus	Mangrove snapper
Caranx hippos	Jack crevalle
Oligoplites saurus	Leatherjacket
Citharichthys spilopterus	Spotfin whiff
Paralichthys lethostigma	Southern flounder
Gobionellus sp.	Goby
Centropomus undecimalis	Snook
Astroscopus y-graecum	Stargazer
Ogcocephalus sp.	Batfish
Achirus lineatus	Sole

5 TO 10 SPECIMENS

Jordanella floridae	Flagfish
Fundulus chrysotus	Golden topminnow
Fundulus similis	Longnose killifish
Lepomis microlophus	Redear sunfish

(Continued)

Table 18

(Continued)

Enneacanthus gloriosus	Bluespotted sunfish
Ictalurus catus	White catfish
Hippocampus hudsonius	Seahorse
Diplectrum arcuarium	Sand perch
Diplectrum formosum	Sand perch
Stephanolepis hispidus	Filefish
Sphoeroides nephelus	Southern puffer
Chaetodipterus faber	Spadefish
Opsanus beta	Toadfish
Acanthostracion tricornis	Cowfish
Etropus crossotus	Fringed flounder
Symphurus plagiusa	Tonguefish

11 TO 25 SPECIMENS

Brevoortia smithi	Menhaden
Elops saurus	Ladyfish
Strongylura notata	Needlefish
Synodus foetens	Lizardfish
Heterandria formosa	Least killifish
Syngnathus louisianae	Pipefish
Trachinotus carolinus	Common pompano
Cynoscion nebulosus	Spotted sea trout
Membras martinica	Rough silversides
Labidesthes sicculus	Brook silversides
Gobiosoma bosci	Naked goby
Prionotus tribulus	Sea robin
Gobiosoma longipala	Naked goby
Prionotus scitulus	Sea robin
Chilomycterus schoepfi	Spiny box fish

26 TO 50 SPECIMENS

Opisthonema oglinum	Thread herring
Strongylura timucu	Needlefish
Strongylura sp.	Needlefish
Fundulus seminolis	Seminole killifish
Cyprinodon variegatus	Sheepshead killifish
Notropis maculatus	Tailight shiner
Notropis petersoni	Coastal shiner
Membras vagrans	Silversides
Trachinotus falcatus	Permit
Microgobius gulosus	Goby

50 TO 100 SPECIMENS

Mollienesia latipinna	Sailfin molly
Menticirrhus focaliger	Kingfish
Orthopristis chrysopterus	Pigfish

for a period of 19 months and they were carried out in the same manner with the same gear and same personnel. The comparison seems to be valid.

(2) *The catch by species.* — Table 17 gives the numbers of all specimens taken over a hundred times. The eight fishes taken over 500 times comprised 74.8 per cent of the total catch of 101 species, or 13,513 of the 16,709 fishes taken. In order of abundance they were: *Menidia beryllina, Mugil cephalus, Anchoa mitchilli, Gambusia affinis, Leiostomus xanthurus, Galeichthys felis, Eucinostomus gula,* and *Harengula pensacolae.*

Table 18 lists the species taken in lesser numbers and it is self-explanatory.

A comparison of the inside and outside catches is given in table 19a. They are considerably different in the order of abundance but of the eight most abundant species in each place the following four species were on both lists: *Anchoa mitchilli, Harengula pensacolae, Mugil cephalus,* and *Leiostomus xanthurus.*

Table 19a also shows that the catches were much higher in the Estuary than in San Carlos Bay. Trawl station 6 in Matlacha Pass had to be abandoned but that will not account for the three times greater catch in the Estuary.

It is of some interest to compare the Estuary part of table 19a with the abundant fishes taken in the St. Lucie (Gunter, 1959, table 13). In the St. Lucie the striped mullet was of overwhelming predominance. The most abundant fishes in the St. Lucie, those taken over a thousand times, were *Mugil cephalus, Brevoortia smithi, Micropogon undulatus, Menidia beryllina,* and *Anchoa mitchilli.* In the Caloosahatchee the four species in this category were: *Menidia beryllina, Anchoa mitchilli, Mugil cephalus,* and *Gambusia affinis.*

Of the fishes taken over 100 times each (13 species in the St. Lucie and 15 in the Caloosahatchee Estuary), eight species were on both lists. These were: *Menidia beryllina, Anchoa mitchilli, Micropogon undulatus, Galeichthys felis, Leiostomus xanthurus, Eucinostomus gula,* and *Sciaenops ocellata.* Furthermore, each list contained a *Cynoscion - regalis* for the Atlantic side and *arenarius* for the Gulf. The samples of these two cognate species are quite difficult, if not impossible, to separate on the basis of a few specimens from opposite sides of south Florida.

Table 19b gives a comparison of seine and trawl catches. The five most abundant species were not taken in the trawls in any numbers except for *Anchoa mitchilli.* However, of the top 10 species taken in each gear, 5 correspond. These were: *Anchoa mitchilli, Eucinostomus gula, Lagodon rhomboides, Leiostomus xanthurus,* and *Eucinostomus argenteus.*

The most abundant families of fishes taken in trawls in order of their decreasing numbers were *Sciaenidae, Ariidae, Engraulidae,* and *Gerridae.*

(3) *The fish catch and salinity.* — The numbers of fishes caught at various salinities are listed for all the abundant species in table 20. Certain species were taken over the whole salinity range and most of these showed peak catches at the lower salinities. Nine species fell into that category. Therefore, the greatest numbers of fishes were taken at the lowest salinities, as previously reported for the St. Lucie. Most of these were juveniles. Four species ranged over wide salinities but the greatest catches of these were made at inter-

Table 19a

The most numerous fishes taken inside and outside the Caloosahatchee Estuary

Estuary		Bay and Beach	
Species	**No. caught**	**Species**	**No. caught**
Menidia beryllina	3,005	Mugil cephalus	1,329
Anchoa mitchilli	2,385	Lagodon rhomboides	413
Mugil cephalus	1,733	Eucinostomus gula	326
Gambusia affinis	1,095	Leiostomus xanthurus	240
Galeichthys felis	651	Harengula pensacolae	223
Leiostomus xanthurus	496	Anchoa mitchilli	234
Trinectes maculatus	405	Menidia beryllina	195
Harengula pensacolae	304	Anchoa hepsetus	145
Lucania parva	294	Menticirrhus littoralis	138
Eucinostomus argenteus	278	Mugil curema	124
Micropogon undulatus	263	Menticirrhus americanus	116
Eucinostomus gula	254	Syngnathus scovelli	110
Sciaenops ocellata	208	Bairdiella chrysura	105
Bairdiella chrysura	175		
Cynoscion arenarius	100	Total	3,828
Total	11,646		

The above 15,474 specimens of 21 species represent 92.6 per cent of the total number of fishes taken.

Table 19b

Order of abundance of most numerous fishes taken in seines and trawls in Caloosahatchee Estuary and adjacent outside waters

Seine Catches		Trawl Catches	
Species	**No. fishes**	**Species**	**No. fishes**
Menidia beryllina	3,200	Galeichthys felis	600
Mugil cephalus	3,062	Anchoa mitchilli	611
Anchoa mitchilli	2,008	Trinectes maculatus	413
Gambusia affinis	1,108	Leiostomus xanthurus	412
Harengula pensacolae	526	Bairdiella chrysura	202
Eucinostomus gula	483	Micropogon undulatus	133
Lagodon rhomboides	388	Eucinostomus argenteus	122
Leiostomus xanthurus	324	Lagodon rhomboides	109
Lucania parva	293	Cynoscion arenarius	101
Eucinostomus argenteus	286	Eucinostomus gula	97
Sciaenops ocellata	211		
Anchoa hepsetus	154	Total	2,866
Menticirrhus littoralis	138		
Mugil curema	135		
Micropogon undulatus	131		
Syngnathus scovelli	110		
Menticirrhus americanus	108		
Total	12,665		

The above 15,531 specimens of 21 species represent 92.9 per cent of the total number of fishes taken.

TABLE 20

Salinity ranges (per thousand) at which the most abundant fishes in all collections were taken — Caloosahatchee Estuary and adjacent waters

	Salinity range per thousand									Total
	<0.5	0.5-1.9	2.0-4.9	5.0-9.9	10.0-14.9	15.0-19.9	20.0-24.9	25.0-29.9	30.0+	catch
Species										
Menidia beryllina	1,897*	495	348	95	67	90	48	115	45	3,200
Mugil cephalus	650	947*	4	119	8	254	108	102	870	3,062
Anchoa mitchilli	1,099*	60	460	51	642	124	75	5	103	2,619
Gambusia affinis	620*	2	2	480				4		1,108
Leiostomus xanthurus	183*	13	161	128	33	2	10	157	49	736
Galeichthys felis	56		7	140	1	464*	9	4		681
Eucinostomus gula	81	43		160*	75	62	32	62	65	580
Harengula pensacolae							1	310*	216	527
Lagodon rhomboides	21	12	28	16	7	12	12	218*	171	497
Trinectes maculatus	352*	5		28		20	8			413
Eucinostomus argenteus	241*	14	1	8	12	37	22	6	67	408
Lucania parva	164*	2		128	1			2		297
Bairdiella chrysura			9	3	162*	1	32	1	72	280
Micropogon undulatus	45		4	116*	82			16	1	264
Sciaenops ocellata	204*		4				4		1	213
Anchoa hepsetus		1			24	2		7	136*	170
Menticirrhus americanus				1	2	11	16	108*	3	141
Menticirrhus littoralis									138*	138
Mugil curema					9	4			122*	135
Syngnathus scovelli				4	1		1	22	83*	111
Cynoscion arenarius	28		8	60*		1	4			101
Total taken in salinity range	5,641	1,594	1,036	1,537	1,126	1,084	382	1,139	2,142	**15,681
Percentage of total	36.0	10.2	6.6	9.8	7.2	6.9	2.4	7.3	13.6	100

NOTES: * Peak catch ** 94 per cent of total catch

Table 21

The total numbers of fishes taken at Seine Station 8 on the Sanibel Island outside beach during ten visits from May 1957 to 2 June 1960

Salinity range 26.5-37.5

790	Mugil cephalus	7	Eucinostomus argenteus
218	Harengula pensacolae	5	Lagodon rhomboides
138	Menticirrhus littoralis	3	Trachinotus falcatus
107	Menticirrhus americanus	3	Syngnathus louisianae
91	Anchoa hepsetus	2	Caranx hippos
75	Menticirrhus focaliger	2	Eucinostomus gula
66	Mugil curema	1	Strongylura marina
47	Leiostomus xanthurus	1	Oligoplites saurus
21	Anchoa mitchilli	1	Bairdiella chrysura
15	Trachinotus carolinus	1	Sciaenops ocellata
13	Menidia beryllina	1	Sphoeroides nephelus

mediate to high salinities. Those fishes were: *Eucinostomus gula, Galeichthys felis, Lagodon rhomboides*, and *Micropogon undulatus*. Certain species showed greatest concentrations in higher salinities and few were taken at lower ranges. These were *Harengula pensacolae, Anchoa hepsetus, Menticirrhus americanus, Menticirrhus littoralis, Mugil curema*, and *Syngnathus scovelli*.

The fresh-water fishes with the greatest abundance at low salinities were taken in fewer numbers and their salinity ranges are given in the tables referred to above.

(4) *The Gulf beach fish populations.* — Surprisingly little information has been recorded on the populations of fishes of the beaches of North America facing the open ocean. Gunter (1958) compared south Texas beach populations with those of the south and middle Atlantic and showed that they were similar in species and family composition. Springer and Woodburn (1960) paid particular attention to a comparison of their data from Pass-à-Grille beach and that collected by Gunter, and they questioned the validity of his comparison of the fish populations from south Texas and the Atlantic coast. Their data were not presented in such a way that they can be analyzed for the numbers caught at particular stations were not given, but we consider that their assumption is not valid because the area in which they worked is subtropical and is probably less comparable in some ways to the Texas coast than the North Carolina and Georgia coast.

Table 21 gives the numbers of fishes caught by the writers at station 8 on the Sanibel Island beach during ten visits. Springer and Woodburn found that *Lagodon rhomboides* was very abundant at Pass-à-Grille, but we found it not to be abundant at Sanibel. Similarly, they found *Leiostomus xanthurus* to be a major component but we found it to be only moderately abundant. Our hauls agreed in finding *Menticirrhus littoralis* in large quantities and in finding *Micropogon undulatus, Trachinotus carolinus* and *Menidia beryllina* in rather small numbers.

In fact, the croaker was absent. Similarly, we both found that *Harengula pensacolae* was present in large numbers. Our own observations agreed with Springer and Woodburn in four out of six instances in which they noted differences with the Texas coast. Table 21 shows that of the fishes taken in the seines at Sanibel six of the ten most abundant species were also among the top ten species noted by Gunter (1958, table 3). The differences between the Sanibel beach and the Texas beach stations do not seem to be quite so much as Springer and Woodburn indicated.

The Invertebrates. — Tables 22 and 24 show that invertebrates were generally sparse in the estuary catches. In fact, the catches would have been more monotonous still were it not for trawl station 4 in the lower part of the estuary where tidal flow brings in salt water from time to time. Eleven species were taken at this lower station and nowhere else. These were: The two *Molgulas*, the oyster, the sponge, *Vermicularia*, the Keyhole Limpet, *Crepidula*, *Lolliguncula*, *Murex*, *Alpheus*, and *Squilla*. Removal of these leaves only 21 species taken over the large expanse of the estuary and that included three fresh-water species—a slug, a crawfish, and a damselfly larva.

The common invertebrate fauna in the catches were the mussels, *Brachidontes* and *Congeria*, the clam, *Rangia cuneata*, the ctenophore, *Mnemiopsis*, and the blue crab, *Callinectes sapidus*. A few pink shrimp were taken.

In great contrast, 107 species of invertebrates were taken in the higher salinity waters of San Carlos Bay, as shown in table 25. Many were taken or recorded only once because they were small, and were skimped over, or could be identified only by specialists.

It is a little difficult to compare the numbers of abundant invertebrates because so much of the mass was made up of large pieces of sponges and colonial tunicates mixed with colonies of soft coral. These materials certainly made up the greatest weight of the invertebrates. Of the discrete, individual invertebrates, the following were the most abundant: *Chaetopterus* worms, hermit crabs (*Pagurites* and *Pagurus*), the stone crab, *Menippe*, the swimming crabs, *Callinectes ornatus* and *C. sapidus*, the sand dollar, *Mellita*, the urchin, *Lytechinus*, the starfish, *Echinaster*, and above all the serpent star, *Ophiolepis elegans* and fewer *Ophioderma*. The tunicate, *Molgula occidentalis*, was also present in large numbers and mass.

Several species of invertebrates were unidentified. One species of crab, *Panopeus*, corresponds to nothing known. An anemone, *Diadumne*, is a similar case and we were asked for more material but none was found. One genus of shrimp, *Processa*, was recorded for the first time from the Gulf of Mexico. The isopod, *Erichsonella floridana*, was recorded for the first time since its description.

Animal Populations and Discharges. — Table 26 compares the fish catch in total numbers and number of species with high and low fresh-water inflows at the same time of year. In January, many more fish were taken with seines and fewer with trawls in the Estuary during high fresh water inflows; the numbers of species were similar. The differences were due primarily to many more small mullet in seine hauls and fewer sea catfish in trawl catches. There was little difference between catches of high and low inflow periods

Table 22

Invertebrates taken in trawls in the Caloosahatchee Estuary

Species	Number	Length range (mm.)	Salinity range
Mnemiopsis mccradyi	Several hundred		3. 5-24. 9
Rangia cuneata	1,573	5- 48	0.09- 8. 6
Rangia nasuta	5	20- 35	0.13- 0.19
Polymesoda carolinensis	109	7- 25	0.13-19. 8
Congeria leucophaeta	Many	-	0.17
Brachidontes recurvus	Hundreds	-	0.09
Crassostrea virginica	Several	-	11. 4-33. 0
Nassarius vibex	5	10- 11	19. 8-33. 0
Neritina sp.	1	-	0.09
Murex sp.	1	-	11. 4
Polynices duplicata	2	-	0.09
Crepidula	1	-	11. 4
Diodora cayenensis	1	-	33. 0
Vermicularia spirata	-	-	16. 0-33. 0
Dendrodoris	10	-	33. 0
Lolliguncula brevis	2	20- 50	27. 5
Penaeus duorarum	34	37-107	3. 5-27. 5
Palaemonetes	4	27- 34	0.56- 8. 6
Pistol shrimp	1	-	11. 4
Freshwater crawfish	1	-	0. 9
Menippe mercenaria	1	-	0. 9
Callinectes sapidus	483	10-185	0.09-27. 5
Molgula manhattenensis	5	6- 11	27. 5
Molgula occidentalis	34	10- 15	27. 5-33. 0

Table 23

Invertebrates taken in seines inside the Caloosahatchee Estuary

Species	Number	Length range (mm.)	Salinity range
Polymesoda carolinensis	1	-	<1. 0
Rangia cuneata	1	-	<1. 0
Crassostrea virginica	1	35	7. 3
Freshwater slug	1	-	0.22
Palaemonetes paludosus	10	18- 33	0.13- 1. 6
Palaemonetes pugio	144	17- 40	0.09-11. 1
Palaemonetes sp	2	24- 33	28. 4
Penaeus duorarum	55	22- 70	<1. 0-11. 1
Callinectes sapidus	98	10-155	0.09-15. 8
Damselfly larva	5	22	0.14-11. 1

Table 24

Invertebrates taken at Seine Stations outside the Caloosahatchee Estuary

Species	Number	Length range (mm.)	Salinity range
Beroe ovata	1	-	18.9
Mnemiopsis mccradyi	3	80	28.7-33.7
Dinocardium robustum	7	30-80	29.1
Chione cancellata	1	-	29.1
Donax variabilis	1	18	32.4
Crassostrea virginica	few	small	24.7
Crepidula convexa	11	-	24.7
Nassarius vibex	22	9-13	28.7
Strombus gigas	many (at station)	-	18.9
Busycon contrarium	1	95	34.2
Aplysia wilcoxi	2	45-50	30.2
Palaemonetes paludosus	1	30	6.6
Palaemonetes pugio	64	18-30	26.5
Palaemonetes spp.	31	15-32	28.7
Palaemon floridana	17	35	24.7-34.2
Penaeus duorarum	84	23-81	9.5-34.2
Tozeuma carolinensis	18	23-33	28.7-34.2
Callinectes ornatus	17	18-100	17.6-35.5
Callinectes sapidus	42	15-60	8.5-31.8
Portunus gibbesi	2	13-20	28.7-34.2
Purple fiddler crabs	2	15-20	17.6
Libinia dubia	3	40-55	34.2
Spotted spider crab	1	40	29.1
Pagurus floridana	1	85	31.8
Emerita talpoida	8	12-17	26.5-37.5
Lytechinus variegatus	9	40-70	29.1
Styella plicata	1	-	29.1

Table 25

Invertebrates taken in trawl hauls outside the Caloosahatchee Estuary

Sponges—several tubfuls of *Microciona* sp., *Haliclona longleyi* and 4 other unidentified species, salinity 22.3 to 37.2.

Species	Number	Size range (mm.)	Salinity range
Campanularia	2 pieces	-	28.5-35.0
Leptogorgia virgularia	60 (app.)	-	21.4-35.0
Leptogorgia hebes	2	-	25.6-33.7
Oculina	2	-	26.8-34.2
Beroe ovata	3	-	25.0
Zoobotryon	sev. bunches	-	30.5
Schizoporella unicornis	5 pieces	-	23.0-32.9
Cerebratulus	1	-	32.9
Chaetopterus tubes (some alive, many empty)	300+	-	21.4-37.2
Eunice rubra	1	20	30.5
Chaetopleura apiculata	2	10	30.5-34.0
Dinocardium robustum	1	-	25.6
Arca transversa	4	8- 15	30.5-32.0
Lima pellucida	1		29.7
Spisula sollidissima	2	12	30.8
Brachidontes recurvus	6	7- 30	31.2
Tagelus divisus	1	(precise station unknown)	
Noctia ponderosa	2	-	32.9
Musculus lateralis	8	-	32.9
Nucula proxima	1	-	32.9
Corbula swiftiana	1	30	32.9
Chione cancellata	1	30	25.6
Pecten ravelli	2	22	34.2
Crassostrea virginica	many small	10- 15	21.4-34.0
Mangela sp	1	-	30.5
Nassarius vibex	7	9- 10	27.9-28.5
Fasciolaria tulipa	1	15	33.7
Odostomia seminuda	1	-	29.7
Mitrella lunata	1	-	29.7
Muricopsis ostrearum	4	-	24.5-32.9
Crepidula convexa	1	15	23.0
Crepidula fornicata	10+	8- 15	23.0-29.7
Crepidula glauca	1	13	27.8
Crepidula plana	1	-	29.7
Fasciolaria hunteria	1	25	34.2
Conus floridana	2	42	31.2-32.9
Cerithium floridana	4	25	31.3-32.9
Cerithium muscarum	5	14- 16	31.2
Canthurus tinctus	3	22- 30	31.2-34.0
Urosalpinx perrugata	1	27	31.2
Vermicularia spiratum	(?)	-	25.6

(Continued)

Table 25

(Continued)

Busycon contrarium	1	105	25.6
Busycon pyrum	1	60	23.0
Busycon spiratum	1	75	32.9
Eupleura sp	1	13	34.2
Murex florifer	2	-	32.9
Pleuropocra gigantea	3	240-285	23.0-33.0
Lolliguncula brevis	7	20-105	24.5-32.0
Erichsonella floridana	2	10	27.8
Alpheus	6	20- 29	22.5-33.8
Palaemonetes pugio	3	13- 19	21.4-27.9
Palaemon floridana	4	25- 35	24.8-30.7
Macrobrachium acanthurus	1	-	32.9
Processa sp.	1	25	33.0
Penaeus duorarum	27	20-110	22
Trachypeneus constrictus	7	17- 46	21.4-25-6
Trachypeneus similis	1	37	22.5
Tozeuma carolinensis	1	-	28.5
Pagurites hummi	40	-	22.3-34.2
Pagurus floridana	24		23.0-33.7
Pagurus longicarpus	3	-	24.5-33.7
Pagurus sp.	2	-	29.7
Cladocera arbuscula	1	-	29.7
Libinia dubia	18	3-138	23.0-34.2
Menippe mercenaria	30+	10- 40	21.4-37.2
Callinectes exasperata	2	-	31.2
Petrolisthes armatus	1	-	21.4
Panopeus occidentalis	2	-	27.8-31.2
Panopeus sp.	2	17	31.2-32.9
Callinectes ornatus	25	10- 46	23.0-27.9
Callinectes sapidus	28	40-165	22.3-33.7
Portunus gibbesi	10	40- 60	23.0-34.2
Portunus spinimanus	3	48- 55	25.6
Pilumnus dasypodus	1	-	35.0
Balanus eburneus	many	Most stations	
Balanus amphitrite nivus	many	Most stations	
Mellita quinquesperforata	42	22-180	24.5-30.8
Moira atropos	1	- 50	24.5
Arbacia punctulata	3	35- 70	25.6
Lytechinus variegatus	83	7- 85	23.0-37.2
Astropecten articulatus	14	27- 70	23.0-32.9
Echinaster sentus	157	10-110	23.0-35.0
Echinometra lacunter	18	33- 50	25.6-37.2
Luidia clathrata	3	165-260	23.0-25.6
Luidia reclivata	6	38- 85	22.3-25.6
Ophioderma brevispina	50	10- 15 (disk)	21.4-34.2
Ophiolepis elegans	3,000 (app.)	6- 20 (disk)	22.3-35.0
Seacucumber	1	45	24.5
Amaroucium stellatum	13 pieces	-	24.5-35.0
Styela plicata	20 (app.)	15-100	24.8-33.8
Molgula occidentalis	350 (app.)	10- 40	22.3-34.2

in seines in the Estuary in June but trawl catches were much less with high flow. January and June trawl catches, both in total numbers and species, were much higher in the bay areas with greater inflows and lowered salinities, but seine catches were greater outside the Estuary in both seasons on low flows. The number of fresh-water species increased somewhat in the Estuary with high discharge and lowered salinities, but some fresh-water forms were taken only during low flows and higher salinity. In the outside bays more salt-water forms were taken more abundantly with less than normal salinities. Differences for season and type of gear must be considered as well as total inflow and salinity concentration, but in general, there are both gains and losses in species and total numbers with high and low fresh-water discharge into the Estuary.

In general, the invertebrate population did not change greatly within the Estuary with high and low inflows of fresh-water, but the change was greater on the outside and the invertebrate populations declined with high discharge.

A great many times more invertebrate species were taken in Pine Island Sound and San Carlos Bay and in the open Gulf than in the Estuary. This increase in numbers of species was not caused by increase in efficiency of the hauls, but was rather due to the increase in numbers of species with the salinity. In fact, the situation is more exaggerated than shown in the tables because several of the specimens were new to the writers and a number of them were minute in size. The counting and identification was rather difficult and there is no doubt that many specimens were unrecorded.

The listing of sponges and colonial tunicates by number is not a proper comparison with individual crabs and shrimp or mollusks. Some of the sponges were fairly large and they made up a great deal of the bulk of the animals caught in trawls outside the Estuary. In fact, this area might be characterized as a sort of sponge reef bottom with numerous soft corals and large numbers of sea urchins and starfish. In mass these were certainly the dominant species, although there was a considerable number of gastropods and crustaceans, which are listed in the tables. If one compares this agglomeration of animals with fossil residues from the Pliocene (Moore and Gunter, 1962), it will be recognized that nothing much but the molluscan components will come through as macro-fossils. The sponges and tunicates disappear, the latter entirely, and the former come through mostly in those species which have silicate spicules. Few of the sea urchins would be readily apparent in a fossil bed. In any case, there seems to be no indication that the type of animal life in this modern coastal lagoon of West Florida is greatly different from that occurring in the same region during the Pliocene times nine to twelve million years ago.

Table 26

Numbers of individuals and species of fish taken inside the estuary and in the adjacent bays in two high and two low fresh-water inflow periods

	PERIOD							
	January 1958		January 1959		June 1959		June 1960	
Total inflow (c. f. s.)	7,800		625		12,300		1,500	
Estuary average salinity*	1.2-2.9		15.0-18.1		0.62-1.3		1.7-3.6**	
Bay salinity average*	13.7-24.2		32.2-32.3		12.7-23-3		26.8-30.5	
Estuary	**Seines**	**Trawls**	**Seines**	**Trawls**	**Seines**	**Trawls**	**Seines**	**Trawls**
Number of fish	1,259	156	377	548	453	92	589	771
Number of species	8	11	11	13	10	7	18	13
Bays and beach								
Number of fish	287	119	344	8	196	122	547	8
Number of species	7	116	10	8	11	23	19	5
Total number	1,546	275	721	556	649	214	1,136	779
Total species	9	25	15	19	18	27	31	17

NOTES: *Surface and bottom averages in p.p.t.

**Heavy rains directly on the estuary lowered salinity even though discharge was low.

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